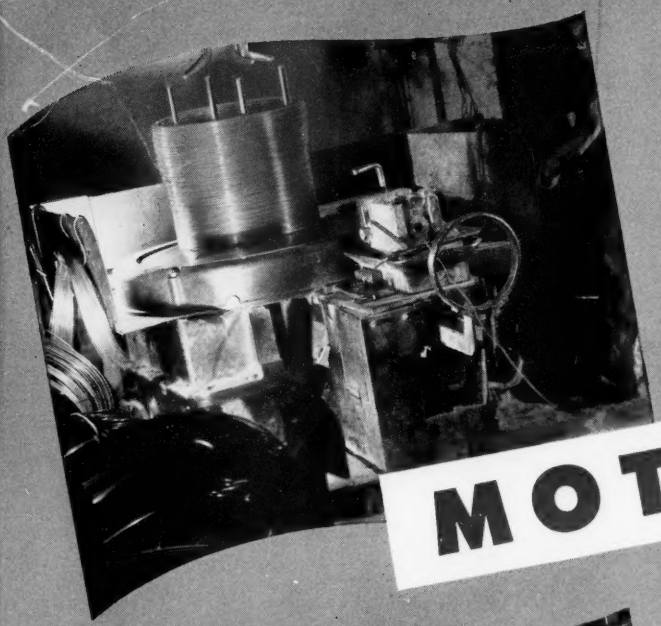
WIRE AND WIRE PRODUCTS

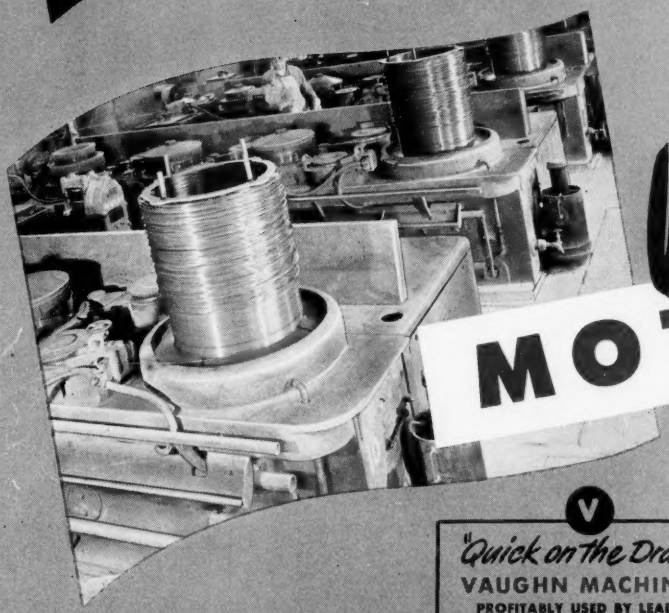
NOVEMBER 1948



NAMES that mean *Everything* IN MODERN WIRE DRAWING

Vaughn MOTOBLOC

Single or double deck types, in six sizes for drawing wire 1" and smaller in coils. A wide variety of adjustable speed ranges covers every production need.



Vaughn MOTOBLOX

Non-slip continuous machines, handling all sizes and grades of wire. Blocks are individually air- and water-cooled. Complete flexibility in speeds and sizes for all mill requirements.

V

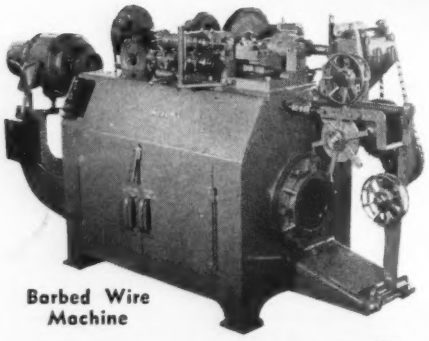
"Quick on the Draw!"
VAUGHN MACHINERY
PROFITABLY USED BY LEADING WIRE MILLS SINCE 1871

THE VAUGHN MACHINERY CO.
CUYAHOGA FALLS, OHIO, U. S. A.
COMPLETE COLD DRAWING EQUIPMENT . . . Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

OFFICIAL PUBLICATION OF THE WIRE ASSOCIATION

Wean EQUIPMENT Corporation

8-inch Single Strand
Wire Flattening Mill
With Wire Straighteners



Barbed Wire
Machine

The WEAN EQUIPMENT CORPORATION is recognized as a specialist in high-efficiency strip and wire mill equipment.

COLD ROLLING MACHINERY

For 36" Wide Material and Narrower

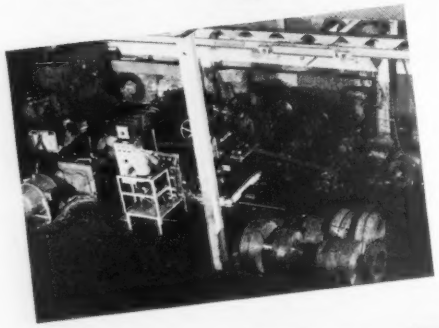
MILLS — REELS — SLITTEPS — LEVELERS
COILERS — EDGERS — SCALE BREAKERS — SHEARS
SCRAP BALLERS — CONTINUOUS PICKLING

WIRE MILL EQUIPMENT

PATENTING, GALVANIZING AND TINNING TAKE-UP FRAMES
WIRE FLATTENING MILLS — SPOOLERS
NAIL GALVANIZING AND BLUEING MACHINES
BARBED WIRE AND FIELD FENCE MACHINES

WEAN EQUIPMENT CORPORATION

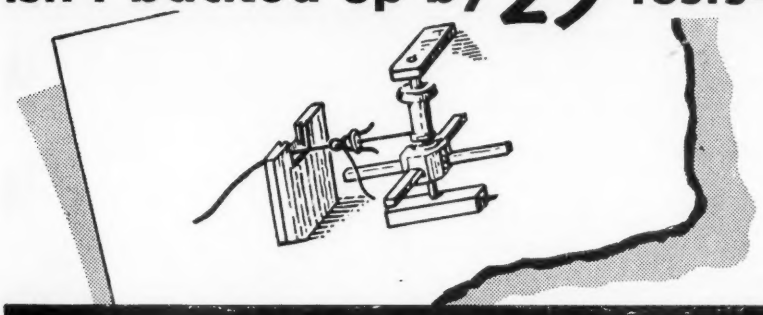
CLEVELAND • OHIO



Wean
Slitting Line

No. 1155
Field Fence
Machine

This die plate isn't backed up by 29 tests—



BUT THESE DIES ARE!

The die plate on this sixteenth-century wire-drawing contrivance *wasn't* backed by twenty-nine tests—quality-insurance—

But your dies of Carboloy Cemented Carbide are!

Every year Carboloy spends thousands of dollars on testing and improving the quality of the dies you use. You should see all the tests for purity and performance they have to pass!

This is just one of the twenty-nine tests, from powder to finished product, that Carboloy Cemented Carbide dies undergo before final release. It is a photo-micrographic examination for checking the micro-structure of the cemented carbide, which must meet Carboloy's exacting specifications.

That's why you can be so sure of quality performance from Carboloy wire-, tube- and bar-drawing products. Let us tell you more about these dies—and about Carboloy's extra benefits and assurances of quality. And ask for the Carboloy DIE SERVICE MANUAL D-119, best of its kind.

CARBOLOY COMPANY, INC., 11171 E. 8 MILE RO AD., DETROIT 32, MICHIGAN

CARBOLOY®

CEMENTED CARBIDE

Silver Star Spring Wire is a special-analysis wire for high-quality coiled upholstery springs. Springs for chairs and sofas, for box springs and mattresses, and for automobile seats.

Leading spring manufacturers everywhere depend on it for uniformity in temper, gauge, and physical properties. Carefully processed in Bethlehem's modern wire mills, Silver Star is your assurance of a quality wire that is readily coiled and knotted. It's adaptable to virtually all upholstery spring designs, especially where quality is foremost.

Engineered solely for coiled upholstery springs, Silver Star Spring Wire is manufactured in a complete range of sizes. The nearest Bethlehem sales office will gladly give you further information—or write to us direct.

BETHLEHEM STEEL

Silver Star SPRING WIRE BETHLEHEM STEEL COMPANY

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem Products are sold by Bethlehem Pacific Coast Steel Corporation

Export Distributor: Bethlehem Steel Export Corporation

WIRE & WIRE PRODUCTS, Vol. No. 23, November, 1948. Publication Office, at 61 Cliff Street, New York 7, N. Y. Executive Office, 300 Main Street, Stamford, Conn. Published monthly by the Quinn-Brown Publishing Corp., Richard E. Brown, President; R. S. Spengel, Secy. and Treas. Subscription price: U. S., $5.00; Canada, $5.00 per year; 50 cents per copy; Foreign, $7.50 per year. Entered as second class matter, June 14, 1946, at the Post Office, New York, N. Y., under Act of March 3, 1879.

here's the NEW PROTECTIVE COATING for live wires

MARVINOL VR-10, the versatile vinyl resin, offers superior stability in protective coatings from raincoats to jackets and coatings for wire. Here are some of the advantages it offers you . . .

MORE STABILITY . . . In processing and in end products, Marvinol offers you greater stability . . . superior resistance to heat, light, oils, acids, aging, wear and other normally destructive forces . . . more positive flexibility in low temperatures. High molecular weight gives Marvinol coats and jackets extra toughness and "dryness."

MORE VERSATILITY . . . Marvinol is easy to formulate for extruding, injection molding and many other processes . . . it's among the most versatile vinyl resins. Wire coatings made from Marvinol may be brilliantly or delicately colored . . . are easily cleaned.

MORE UNIFORMITY . . . Marvinol resins are a development of Martin research and Martin's quarter-century of plastics experience. Produced in the world's most modern chemical plant, they assure unexcelled uniformity. The Glenn L. Martin Company does not compound or fabricate in the plastics field. If you make or coat wire, our sales engineers and customer service laboratory offer full technical cooperation. If you buy or use finished wire, write to Chemicals Division, Dept. **W-11 The Glenn** L. Martin Company, Baltimore 3, Maryland.

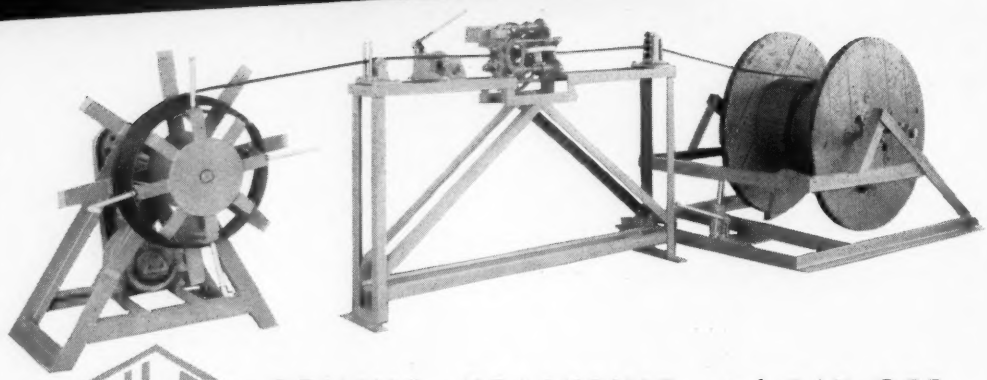
Martin ★ Marvinol

RESINS, PLASTICIZERS AND STABILIZERS PRODUCED BY THE CHEMICALS DIVISION OF
THE GLENN L. MARTIN COMPANY • AN INTERNATIONAL INSTITUTION

"BETTER PRODUCTS, GREATER PROGRESS, ARE MADE BY MARTIN."

The Easy-Accurate-Economical Way

To COIL, MEASURE and CUT Wire Rope and Wire Strand In The WAREHOUSE is The JLE Way!



JLE COILING, MEASURING and PAY-OFF EQUIPMENT FOR WAREHOUSE USE IN HANDLING WIRE ROPE and WIRE STRAND

A Complete set of JLE warehouse equipment includes:

PAY-OFF REEL STAND — MEASURING MACHINE — HAND-OPERATED HYDRAULIC WIRE ROPE CUTTER — MEASURING MACHINE STAND — COILING MACHINE OR REEL TAKE-UP

The JLE sets of equipment are available in a varying range of capacities with the maximum set as follows:

Pay-off Reel Stands up to 84 inch diameter and 10 tons.
Measuring Machines up to 2 inch diameter cable.
Hydraulic Wire Rope Cutter up to 1½ inch diameter.
Coiling Machine up to 42 inch barrel diameter, or —
Reel Take-ups up to 84 inch diameter and 10 ton Reels.

Also available are:

Pay-off Reel Stands and Reel Take-ups in the Reel-Jacktype of construction.
Combination Coiling with optional Reel Take-up for light reeling.
This JLE equipment may be purchased as complete sets or as individual units. Send for complete catalog section 21A for full information.

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JLE

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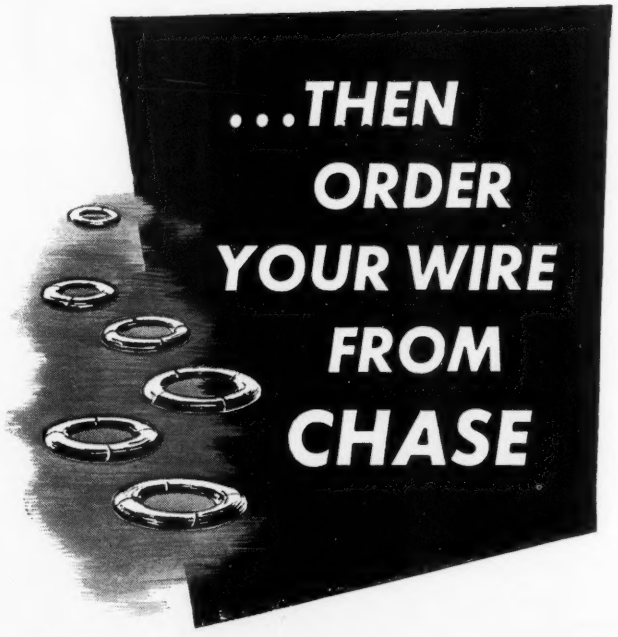
JLE

WATCH CLOSELY PLEASE!



THIS is a test that all Chase copper-alloy wire produced for spring purposes must undergo before becoming a bona fide Chase product. It's a very critical one—which can be met only by wire of the highest quality —and consists of giving the wire a 360° coil or wrap around its *own* diameter to test its ductility and determine its physical qualities.

Every one of the 22 different types of wire alloys, regularly produced by Chase, must undergo tests that are just as rigid, or more so. And every one is carefully formulated, free from physical defects, perfectly "cast" for uniform uncoiling.

Don't compromise. Order the *best* wire from any one of the many Chase Warehouses and Service Offices from coast to coast.

Chase *the Nation's Headquarters for* **BRASS & COPPER**

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THIS IS THE CHASE NETWORK . . . *handiest way to buy brass*

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Testing G-E cable tape for thickness and evenness.

You can depend on G-E Cable Tape because it's "QUALITY TESTED"

G-E CABLE TAPE MUST PASS 5 TESTS

1. G-E cable tape is carefully tested for thickness, and evenness of application of high-quality insulating varnishes.

2. G-E cable tape shows excellent dielectric strength by meeting a break-down voltage of 1000 volts per mil at room temperature. In oven tests, G-E cable tapes meet or exceed a break-down voltage of 750 volts per mil at 85 C.

3. Heat testing subjects G-E cable tape to 125C for many hours, with periodic checks for brittleness by bending the tape around an ⅛ inch mandrel.

4. G-E cable tape passes the test for tensile strength by standing a pull of 3000 pounds per square inch, much more than specifications require.

5. G-E cable tape meets and exceeds the established specification for tearing strength, thereby ensuring good mechanical strength.

● Each lot of G-E cable tape is tested in a modern control laboratory for the important electrical and insulating properties. Using I.P.C.E.A. specifications as a guide, the laboratory makes sure that G-E cable tapes meet or exceed those standards.

Exhaustive tests have proven that the important properties of an outstanding cable tape are present in G-E tape—dielectric strength, tensile strength, tearing strength, resistance to heat and weathering—all qualities which are vital in a quality insulation.

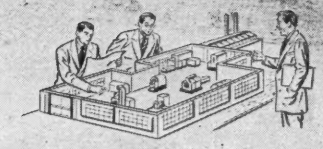
For further details write to Section CG-11, Resin and Insulation Materials Division, Chemical Department, General Electric Company, Schenectady 5, N. Y.

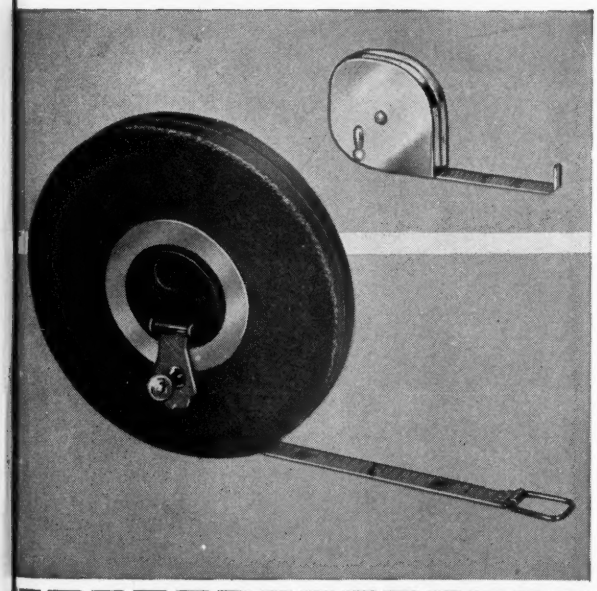
CABLE TAPE

GENERAL ELECTRIC

CD48-T1

Confidence- WITH ITS SLEEVES ROLLED UP!





STRAIGHT AND STALWART, every factory stack is a towering symbol of man's faith in the future... industry's confidence in its ability to create and to expand production for better living and a richer world.

With confidence like that, Roebling has pioneered in developing and making an extraordinary range of products indispensable to industry. And the confidence that its products and engineering skill have earned in every industrial field is one of Roebling's most valued assets. Every Roebling employee is striving to safeguard that confidence by making products and rendering services that are of maximum utility to you.

MEASURE THIS FLAT WIRE BY ANY STANDARD

SIZE UP ROEBLING FLAT WIRE... its steel analysis, dimensional uniformity, temper, finish. You'll find it's *right* on every count . . . meets specifications and helps beat mounting production costs.

Roebling looks out for you by controlling each step in the manufacture of its flat wire . . . makes its own steel to assure the right metal composition . . . produces wire by means of modern, highly specialized equipment and techniques . . . constantly applies the results of research and development to give you the finest flat wire that can be made.

Specify Roebling Flat Wire with confidence that it will meet your requirements. Your Roebling Field man will help you determine the *right* wire for the job, and the right way of handling it. Write or call your nearest Roebling branch office.

JOHN A. ROEBLING'S SONS COMPANY
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Branches and Warehouses in Principal Cities

A CENTURY OF CONFIDENCE **ROEBLING**

JR ROEBLING

★ WIRE ROPE AND STRAND ★ FITTINGS ★ SLINGS ★ SUSPENSION BRIDGES AND CABLES ★ AIRCORD, AIRCORD TERMINALS AND AIR CONTROLS ★ AERIAL WIRE ROPE SYSTEMS ★ ELECTRICAL WIRE AND CABLE ★ SKI LIFTS ★ HARD, ANNEALED OR TEMPERED HIGH AND LOW CARBON FINE AND SPECIALTY WIRE, FLAT WIRE, COLD ROLLED STRIP AND COLD ROLLED SPRING STEEL ★ SCREEN, HARDWARE AND INDUSTRIAL WIRE CLOTH ★ LAWN MOWERS

HUDSON WIRE COMPANY

PRODUCERS OF FINE WIRES IN ALL METALS

FINE BARE WIRES

High Brass, Low Brass, Zinc 99.99+ and High Tensile Zinc, Commercial Bronze, Phosphor Bronze, Pure Tin, Lead, Antimonial Lead, Tinsel Lahns, Silver Plated Copper, False Gold and Copper.

Cadmium, Nickel Silver (10%, 18%, 30%), Silver Plated Copper, False Gold and Special Brass and Bronze Alloys to Specification, Metallic Fibre for Packing Purposes, Copper, Bronze, Zinc, Lead and Aluminum.

WIRES FOR METAL SPRAYING

Pure Lead, Lead Alloys, Pure Zinc, Zinc Alloy, Copper, Tin, High Brass, Low Brass, Solder Wire, High Conductivity Electric Wire.

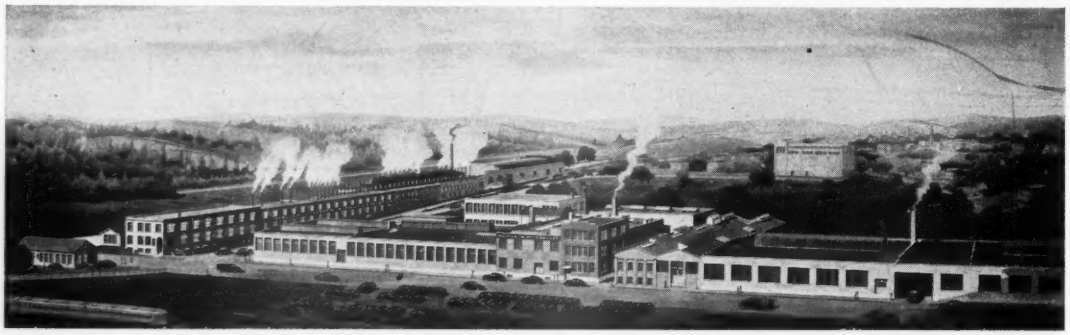
Cadmium, Nickel Silver (10%, 18% 30%), Aluminum, Monel Metal, Phosphor Bronze, Pure Nickel, Commercial Bronze.

Look for the name — **HUDCO** — A guarantee of quality

"HUDCO" specially processed Copper Wire for enamelling purposes is drawn from Selected Copper, insuring the maximum conductivity. This is but one example of the use of the most advanced and approved materials and methods in our processing.

BETTER WIRE AT LOWER COST

Write for Prices and Samples • Let Us Quote on Your Requirements

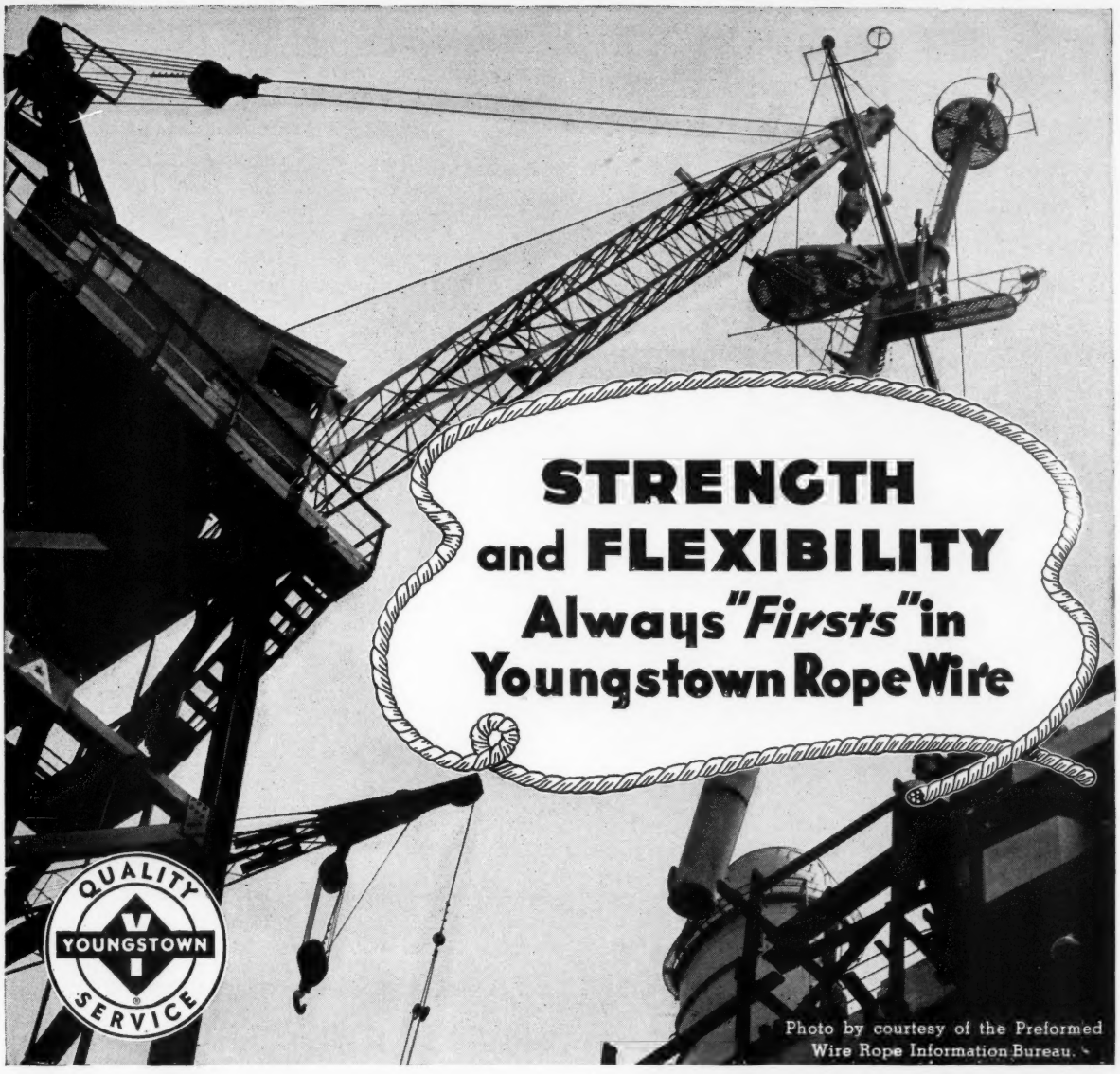


"HUDCO" PLANT AT OSSINING, NEW YORK

HUDSON WIRE COMPANY

Established in 1902 — Successors to Royle & Akin

OSSINING, NEW YORK



Neptune's Workshop

IN the shipyards, steel cable must be of proven, dependable quality. It must have plenty of extra strength for continuous lifting of many-ton loads. It must flow over sheaves fast, smoothly, with never a kink. It must have long life.

Much of the steel cable used in "Neptune's workshops" is fabricated from Yolectro High Carbon Rope Wire. Like all other Youngstown wire mill products, this wire is of finest quality steel, refined, rolled and drawn to rigid specifications, to make a product carefully balanced as to strength, flexibility, and toughness.

When you need wire rope, specify that it be woven from Yolectro High Carbon Rope Wire. Then you can depend on your cable's having those essential qualities you want.

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THE YOUNGSTOWN SHEET AND TUBE COMPANY

GENERAL OFFICES - YOUNGSTOWN 1, OHIO

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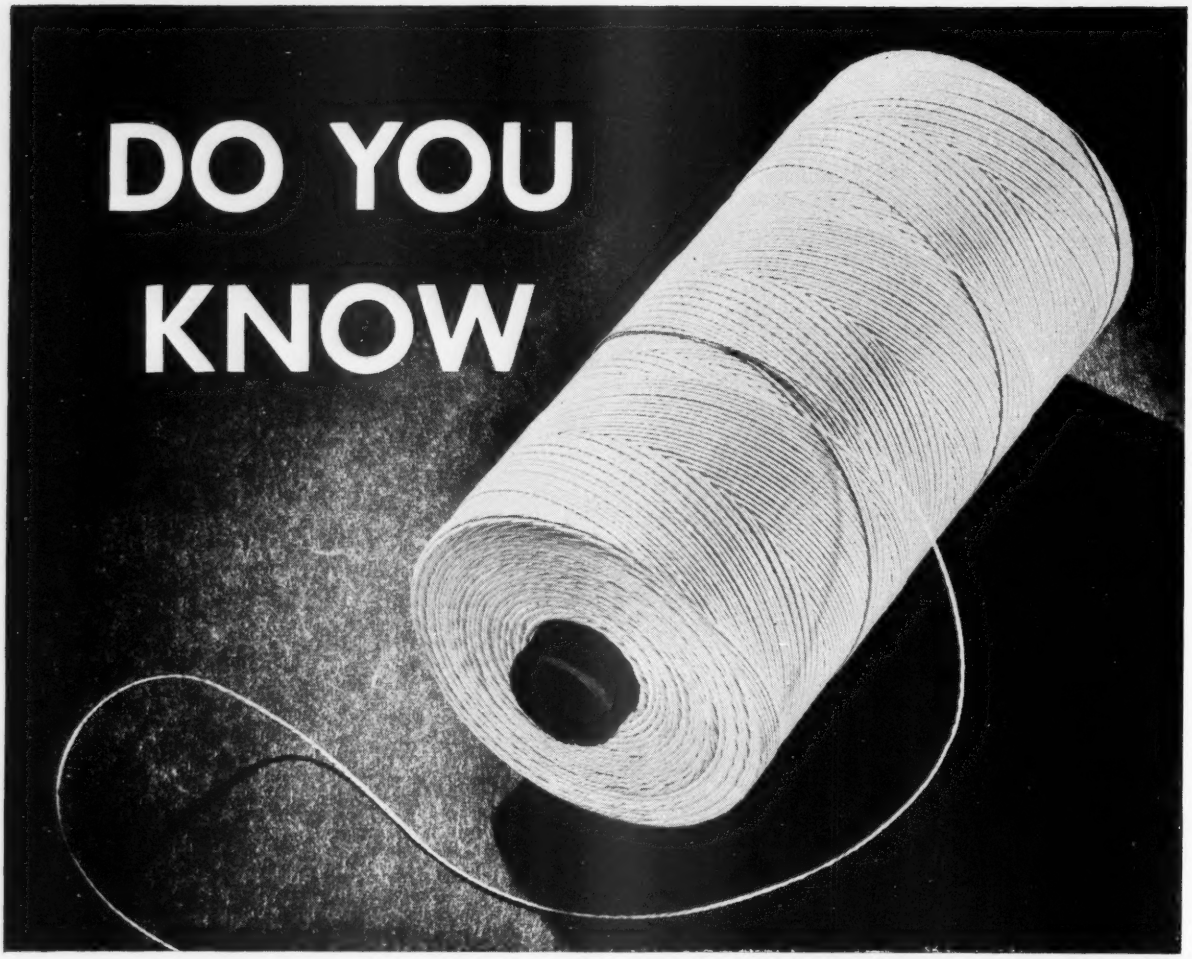
Manufacturers of

CARBON - ALLOY AND YOLOY STEELS

Bars-Rods-Wire-Cold Finished Carbon and Alloy Bars-Sheets-Plates-Pipe and Tubular Products-Conduit-Electrolytic Tin Plate-Coke Tin Plate-Tie Plates and Spikes.



...why Fiberglas* 150's Yarns are being used for supporting braids or wraps for the jackets of portable cords?

- HIGH TENSILE STRENGTH
- PERMANENT—WILL NOT ROT
- WILL NOT BURN
- SMALL SIZE—PERMITS THICKER JACKET WALL —IMPROVES APPEARANCE
- LOW COST

For complete information about Fiberglas Yarns for this and other electrical uses, write Owens-Corning Fiberglas Corporation, Dept. 875, Toledo 1, Ohio. Branches in principal cities.

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OWENS-CORNING FIBERGLAS Yarns

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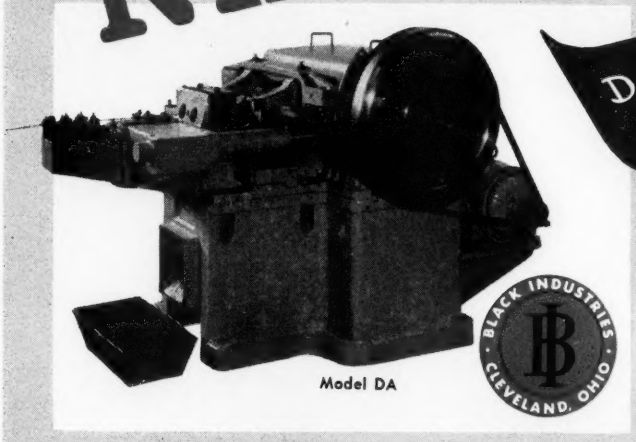
NEW WIRE NAIL MACHINE



Model DA

Designed and built by BLACK

- HIGH SPEED
- HEAVY DUTY
- LOW OPERATING COSTS

Write for literature listing specifications and new features. Quick delivery on most models.

BLACK INDUSTRIES

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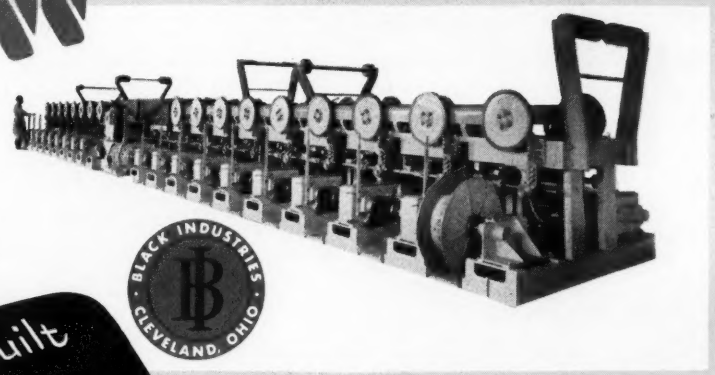
Designers • Engineers • Builders of Steel and Wire Mill Equipment

NEW 36 REEL WIRE TAKE-UP FRAME

- CONSTANT TENSION
- NO-SLIP CLUTCHES
- NO RIDERS ON WIRE
- SIMPLIFIED CONTROLS
- ALL A. C. DRIVE



Designed and built by BLACK

Used in processing line for plating steel wire. This principle can be adapted to other processing or product lines for taking up strip or wire products. BI engineers will modify the design to suit the requirement for single units or multiple-reel or block-type frames.

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Free FOR THE ASKING

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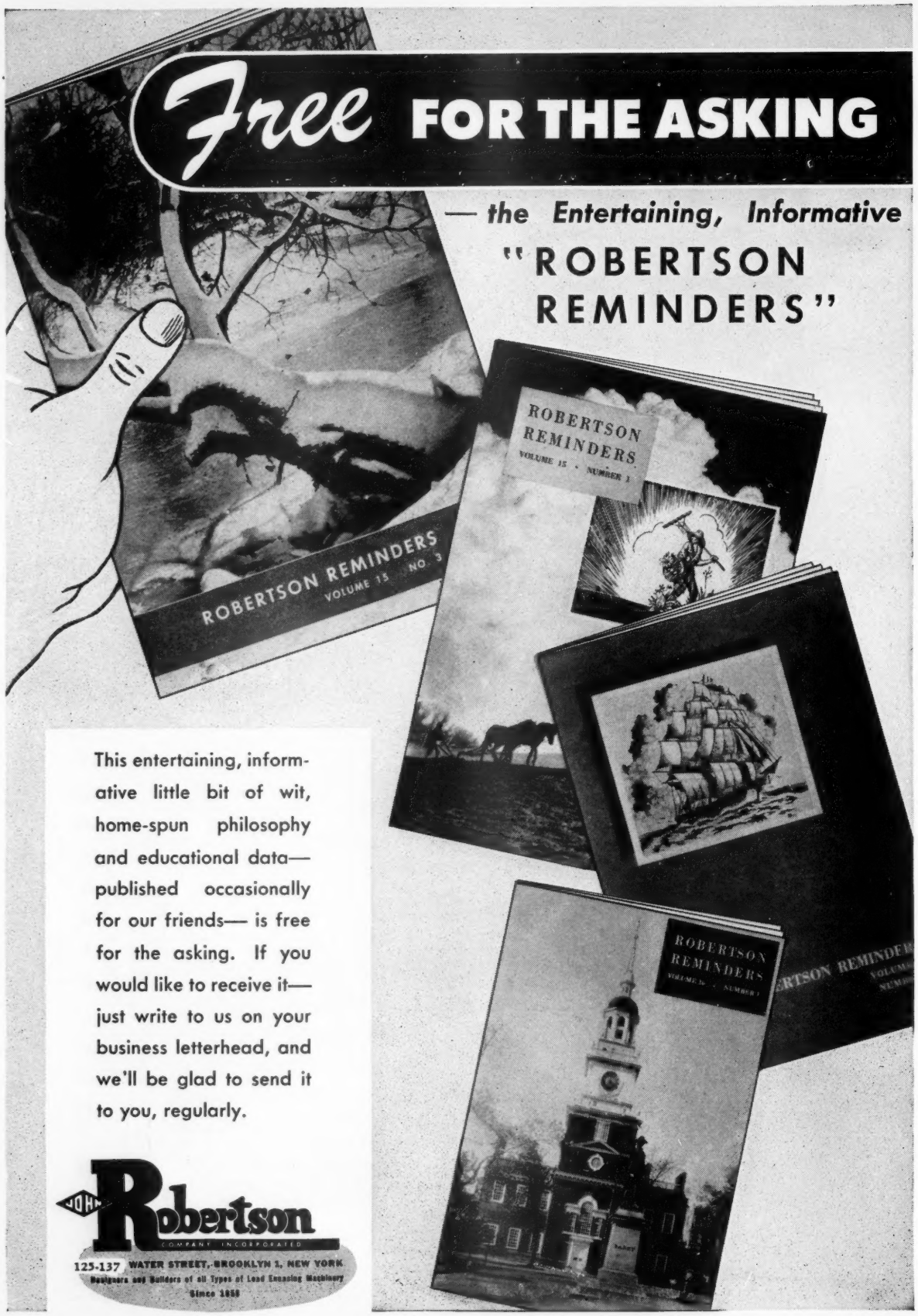
"ROBERTSON REMINDERS"



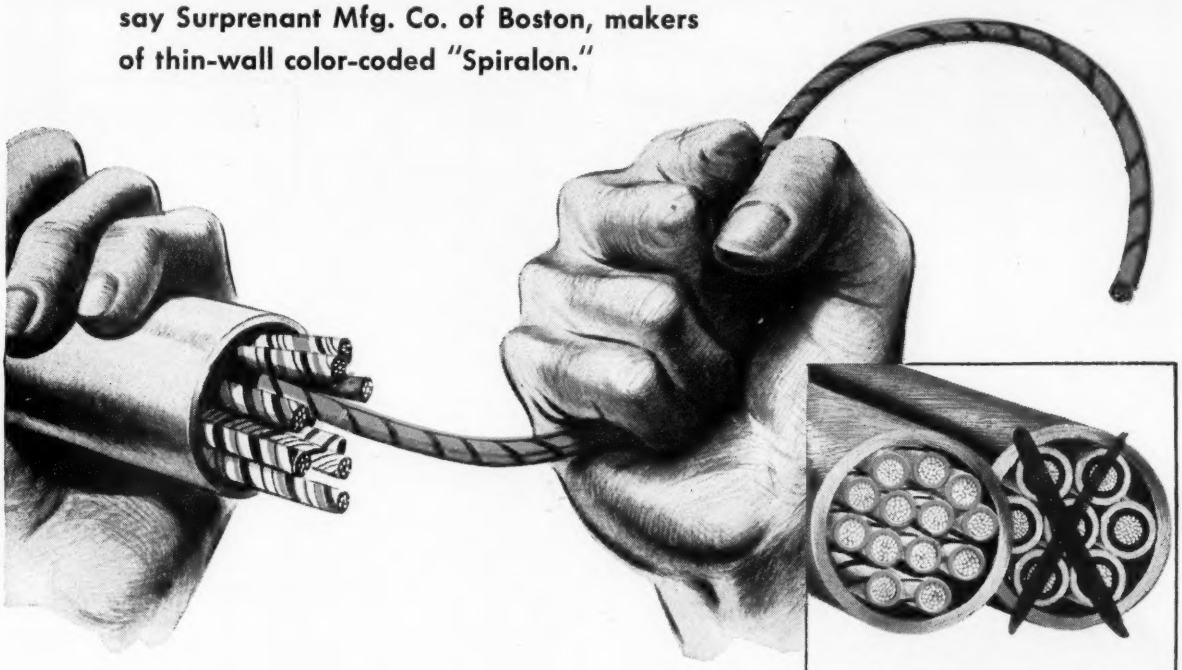
This entertaining, informative little bit of wit, home-spun philosophy and educational data— published occasionally for our friends— is free for the asking. If you would like to receive it— just write to us on your business letterhead, and we'll be glad to send it to you, regularly.

JOHN Robertson
COMPANY INCORPORATED
125-137 WATER STREET, BROOKLYN 1, NEW YORK
Designers and Builders of all Types of Lead Encasing Machinery
Since 1858

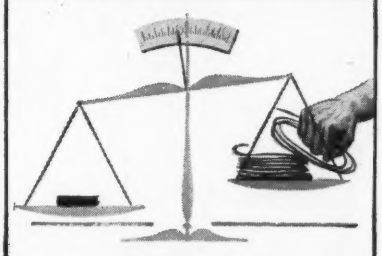
Why are big wire producers using Du Pont NYLON plastic?

"Unsurpassed as a protective jacket for wire,"

say Surprenant Mfg. Co. of Boston, makers of thin-wall color-coded "Spiralon."

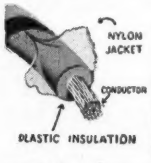


Wire has **SMALLER DIAMETER,** permits more wires in limited area.



Wire is **LIGHT IN WEIGHT,** and resists heat, oils, water, chemicals, abrasion and flexing.

"Jacketing of Du Pont NYLON helps us produce a color-coded wire with fungus- and abrasion-resistance, extra smoothness for easier pulling, and many other advantages."



"Our new 'Spiralon' wire is available in many thousands of distinct color combinations, making identification easy even in the most complex installations," report Surprenant Manufacturing Company. "It consists of a conductor, color-coded plastic insulation, and a transparent protective jacket of Du Pont nylon. The nylon cover can be applied easily and rapidly. It's *extra smooth*. It's tough and long lasting. It resists heat, oils, many chemicals, abrasion, and flexing. And nylon helps us produce a wire with *smaller diameter* and *lighter weight*. We feel it is unsurpassed as a thin-wall extruded covering."

Know these facts—for profits

Wire, cable and many other electrical products today are *better* products, because of Du Pont nylon. This Du Pont plastic can be molded or extruded, and colored to fit specifications. For your own good—don't overlook its remarkable properties. Write for free booklet, "65 Success Stories of Product Improvement." Filled with helpful facts. Just address: E. I. du Pont de Nemours & Co. (Inc.), Plastics Dept., Room 1511, Arlington, N. J.

TUNE IN Du Pont's "Cavalcade of America"—Monday Evenings—NBC coast to coast.

CHECK THESE 7 BASIC FEATURES OF NYLON FOR ELECTRICAL USES

1. Good flexibility
2. High tensile strength
3. Extreme toughness
4. Abrasion resistance
5. Resistance to permanent set
6. Chemical resistance
7. Ability to be molded or extruded . . . colored or in natural color.

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REG. U. S. PAT. OFF.
Plastics
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

HUBBARD *New Type* HEAVY DUTY STEEL SPOOLS

For Modern High-Speed Screen Cloth Manufacture

These new type HEAVY DUTY HUBBARD STEEL SPOOLS are made of heavy gauge steel, with special washer type reinforced flange to resist the lateral pressures caused by modern high-speed spooling operations. Joints are brazed and smooth finished to assure tight joints that will not trap wire. Accurately balanced for true performance. Built to withstand impact and abuse. May be had in all standard sizes. Let us send you complete information.

HUBBARD SPOOL COMPANY
1624 Carroll Avenue • Chicago 12, Illinois

DID YOU KNOW

...it is possible to weave many types of screen cloth *directly* from the new type HEAVY DUTY HUBBARD STEEL SPOOLS... and eliminate the use of warping drums—thus getting rid of an expensive operation and cutting down costs proportionately. Write us for full details.

Hubbard

STEEL SPOOLS AND REELS... METAL BOUND
SPOOLS AND REELS... STEEL TRAVERSES
LIGHT WEIGHT REELS... WOOD REELS

ALUMINUM WIRE GOODS WITH *Colors* IN THEIR SKINS

RUBBISH CONTAINERS

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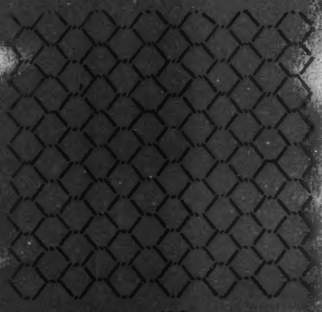

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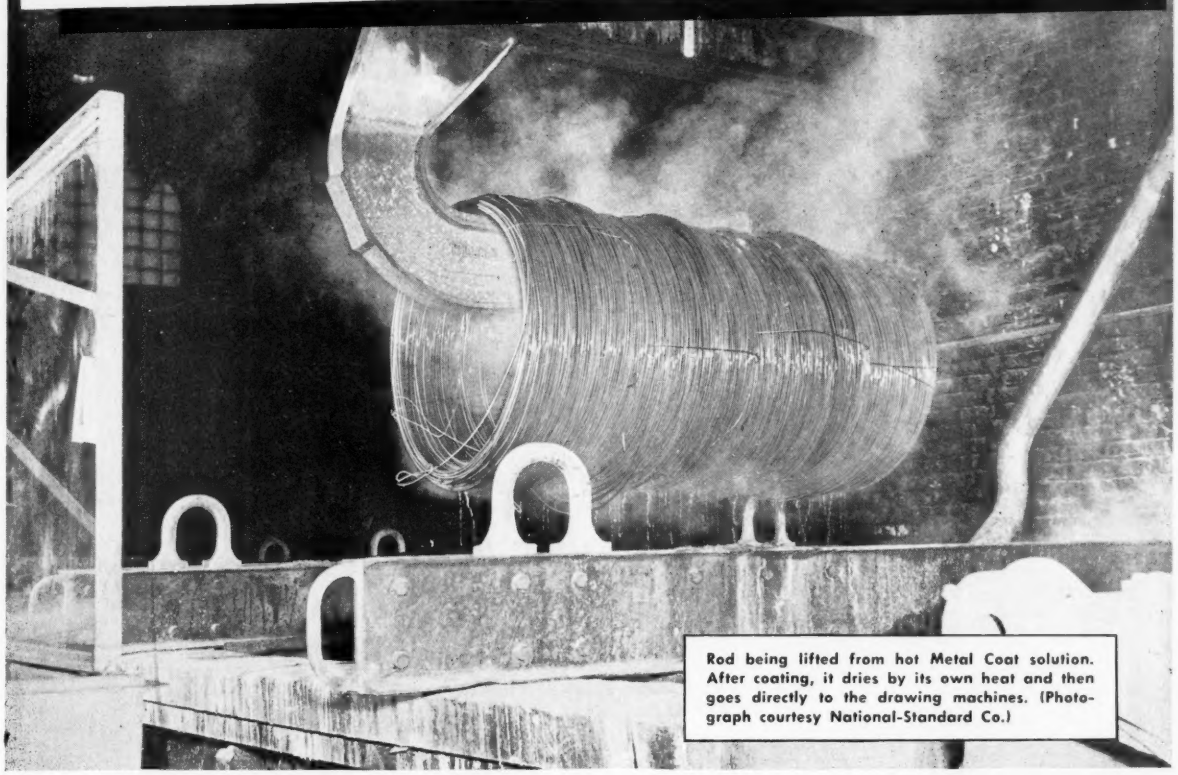

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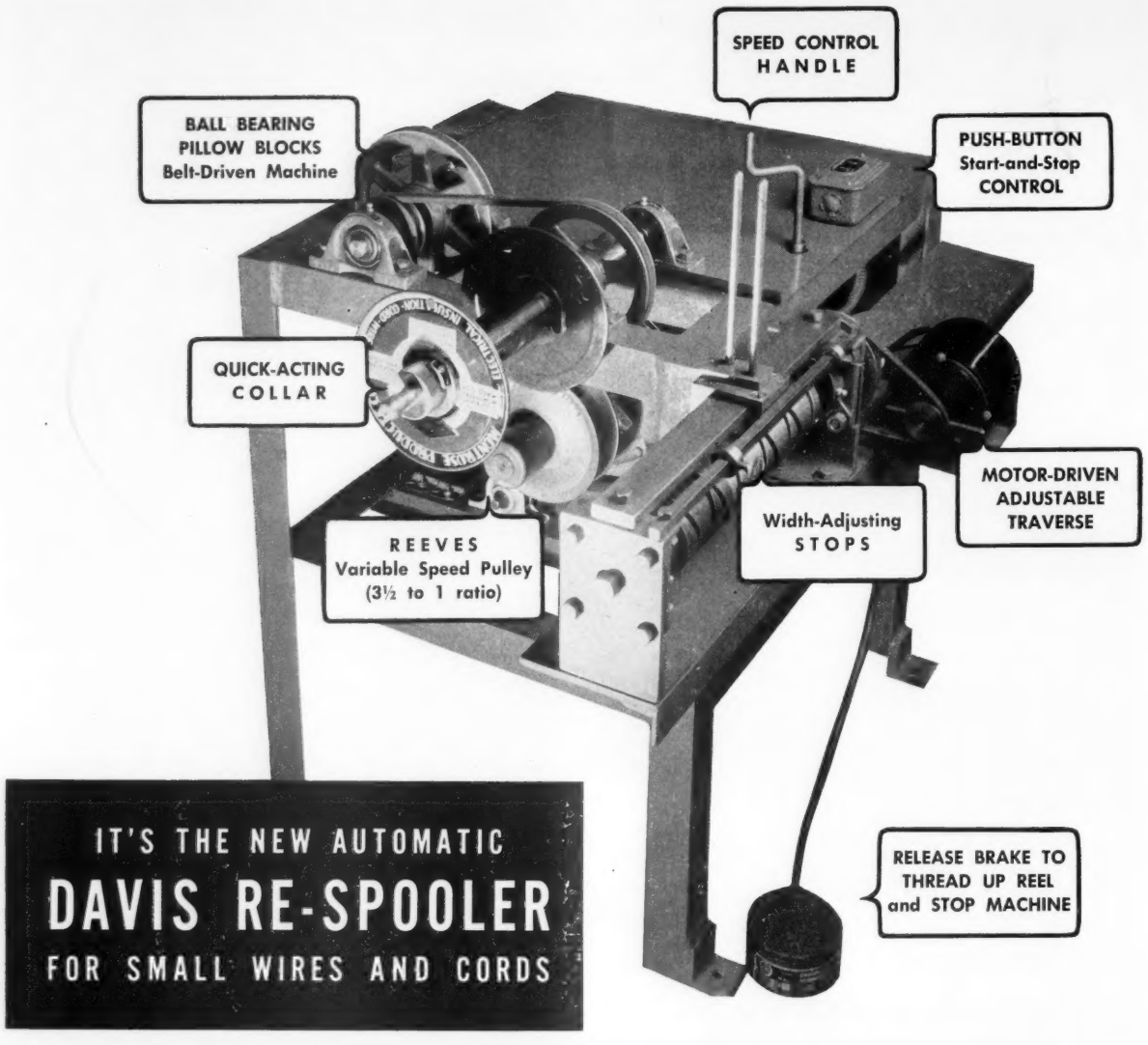
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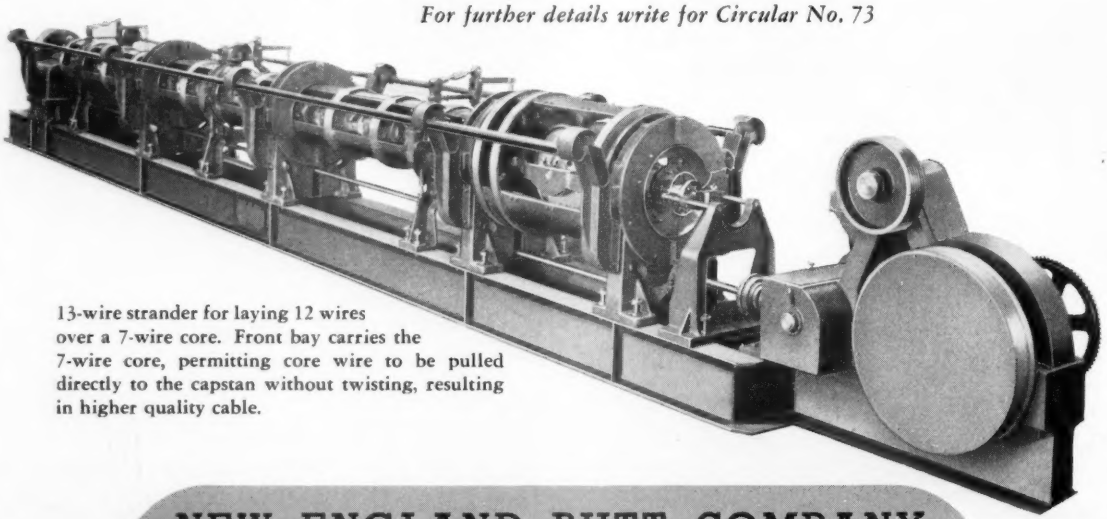

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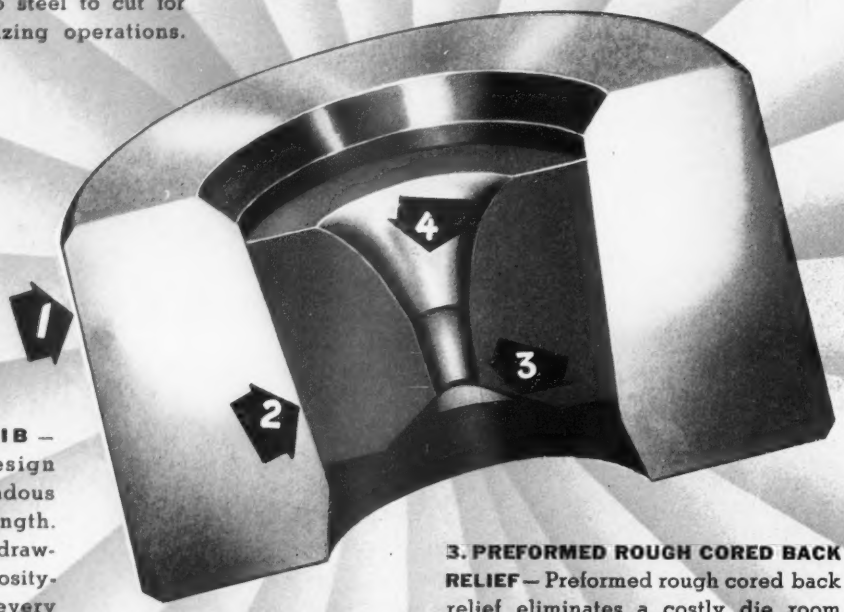

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The Wire Outlook

It seems trite to even refer to the threat of war, but Russia's proneness to childishly provocative acts may at any time result in an "incident" that will touch off the super-heated powder-keg of Europe.

War or no war, we will feel the effects of preparedness measures through increased expenditures, greater allocations of critical materials, higher taxes and growing shortages of consumer goods. All of this will provide an unneeded shot in the arm to an economy that is already fraught with inflationary tendencies through our struggle to catch up with unfulfilled demands for the products of industry.

By the time this editorial appears it is highly probable that the election will have resulted in a change in leadership that will unify, strengthen and make efficient a government that long since proved its inability to cope with national and international measures that make for soundness and security. One of the most heartening results of the change is likely to be a cleaning out of subversive personnel that have occupied posts of trust and authority under the New Deal.

Inflation must be checked. The Marxian theory that the quickest way to destroy a middle-class society, so essential to democracy, is through inflation — a truism to be faced. Neither inflation nor depression is desirable nor necessary. Both can be avoided if Governmental extravagance is eliminated and activities coordinated, so that we are not torn by conflicting policies from within.

Importers and producers of copper, lead, zinc, cadmium and other strategic metals may be asked to set aside percentages of these materials for government stockpiles. Domestic users are increasing the pressure of their demands on suppliers and market tones are strong. Aluminum production, cut back by power shortages, is climbing steadily, but stocks of pig, due to demand, are lower than ever.

A larger inflow of German scrap may ease domestic requirements somewhat, although not sufficiently to end the shortage. For this reason, the various drives to collect and distribute scrap should be continued unabated. More than ever will be required when the rearmament program gets into full swing.

Steel production is running in excess of 95% of capacity. Higher ingot tonnage is forecast for 1949, with an output of 94,000,000 tons, without benefit of new basic equipment, of which exports, under ERP, will take around 10%. It is too early to say whether the increase will be reflected in a proportionate betterment in rod supply.

Wire rod supply has shown some improvement since early Fall, but lacks balance. Screw producers are drawing some wire from rods; substantially, however, they depend on finished wire. A few merchant wire products have declined, demand for bale ties is down, but nails continue to be acutely short. Building activity is 30% higher than a year ago, with 950,000 new homes estimated for 1948 construction — an all-time record. The overall demand for wire products continues to be greater than supply, with stocks practically non-existent.

Calls for fine wire specialty, fastener and spring wire, have been lighter, although for every type of wire on which there is a let-up, demands from other directions take up the mill slack.

It has been suggested that concerns who are interested in export markets turn their attention to South America, which offers a potentially important, stable and long-term outlet for steel products. While many South American countries have made vast strides industrially, they have come nowhere near meeting their own needs.

Certain it is, come what may, that our mills and factories will be busy for a long time. During this interest of an artificially stimulated economy, it is to be hoped that we will not be too busy to put our house in order for the normal times still in the distant future.

—from the Editor's Desk

the Honeymoon is over

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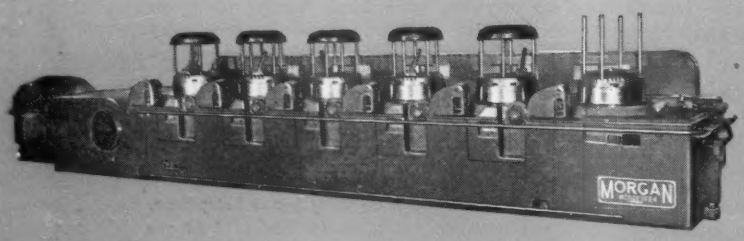

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A monthly publication devoted to the production of Wire, Rod and Strip, Wire and Rod Products and Insulated Wire and Cable.
DRAWING — ROLLING — EXTRUDING — FORMING — FABRICATING

Vol. 23 NOVEMBER, 1948 No. 11

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Contents

Editorial Page 1033

Wear Resistance of Wire for Wire Rope by Reginald S. Brown 1037

Evaluation of Pickling Inhibitors from the Standpoint of Hydrogen Embrittlement. II Acid Pickling of Carbon Steel ..... by C. A. Zapffe and M. E. Haslem 1048

The Handling of Webs and Monofilament Materials by C. A. Litzler 1054

Industrial Diamond Association Letter 1056

Outstanding Personalities of the Wire Industry 1059

A Review of Recent Patents 1063

Labor Relations ..... by John B. Stone 1077

Index to Advertisers 1083

Where-to-Buy 1084-1088

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WIRE
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A monthly publication devoted to the production of Wire, Rod and Strip.
DRAWING — ROLLING — EXTRUDING — FORMING — FABRICATING

Vol. 23 NOVEMBER, 1948 No. 11

Wear Resistance of Wire for Wire Rope

by Reginald S. Brown, Chief Metallurgist
Rylands Brothers, Ltd.
Warrington, England.

A paper presented before the Wire Association Convention at Pittsburgh, Pa., October, 1948.

OF the two major causes of wire rope breakdown — wear and corrosion fatigue — the mechanism of wear, owing to its complexity has so far received little or no attention. Fatigue and corrosion fatigue phenomena have been subjected to searching analysis and our knowledge, if not our control of them is today fairly complete.

* * *

THE influence of wear as distinct from corrosion plays a major part in fatigue breakdown, both internally in crane ropes, winding ropes and the like, and externally in mine haulage and aerial carrying ropes. In the former, the cross cutting of wires causes "stress raisers" i.e., local concentrations of stress beyond the Safe Fatigue Range, whereas in the latter case, brittle surface-flowed films, by cracking under bending influences produce similar effects.

* * *

IN both cases the result is the same — i.e., the inception of slow development cracks which ultimately result in what are popularly termed fatigue fractures. Fig. 1. illustrates a crack commencing in a brittle surface-flowed film on a haulage rope wire and Fig. 2. which is a longitudinal microsection, shows this crack propagating across the

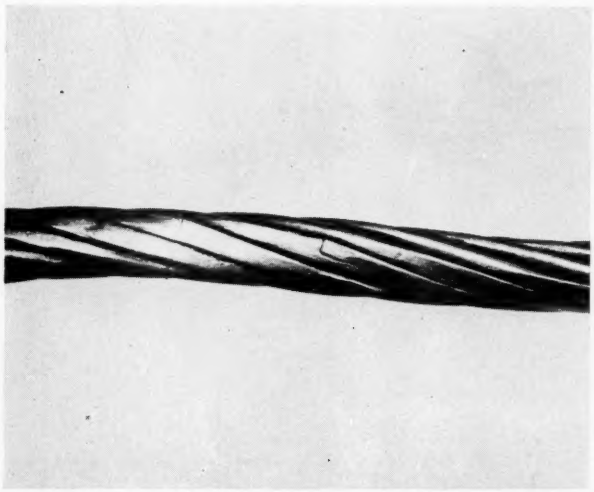


Fig. 1. — Fracture in worn surface of wire from a Haulage Rope. XI

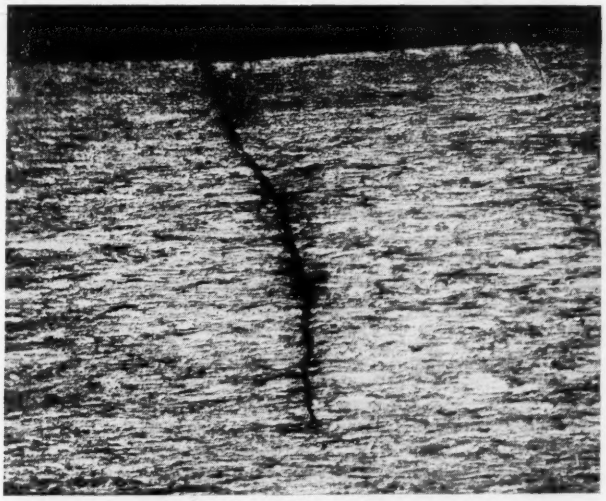


Fig. 2. — Microsection through fatigue crack. X 100

wire section. The influence of the ultimate fatigue value of the wire as drawn is thus of little importance where wearing conditions are present, as is indeed the case with most ropes in service. It is therefore in the direction of wear resistance that we must turn if any measurable improvement in the service life of wire ropes is to be effected.

* * *

HITHERTO it has been the general practice throughout the industry to produce rope wire by empirical methods, no discrimination being made between wire for the various types of ropes used in which ultimate failure is due to a variety of causes. In standardising wiredrawing mill practice no account has hitherto been taken of these causes but it would seem pertinent to enquire whether such standardisation is desirable and whether conditions of manufacture can be modified in particular instances to yield greater resistance to ultimate failure. Haulage ropes, both underground and those used for aerial carriage, almost invariably fail due to wear and manufacturing variables have been found in practice to have a profound influence on the resistance to the so-called "plastic" wear as shown by the greatly improved life of heavy duty haulage ropes manufactured from high tensile strength wires. In the past, ropes made from wires of this type have been viewed with suspicion owing to their greater tendency to fatigue breakdown of the type shown in Fig. 1., but some exploratory work has shown that this effect might be capable of control by careful modification of manufacturing procedure in a modern patent steel wire mill.

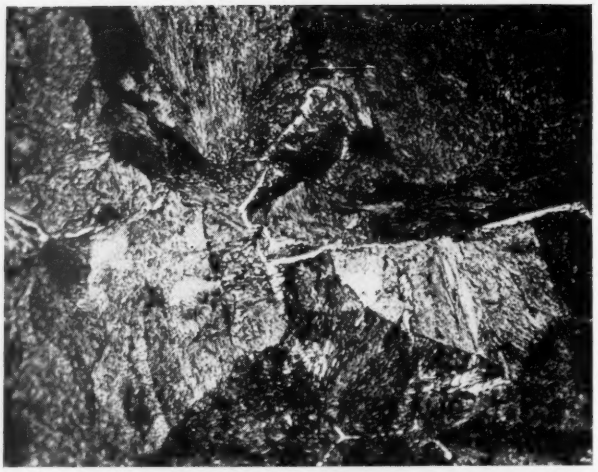


Fig. 3. — Microstructure of wire rod lead patented at 590°C. X1250

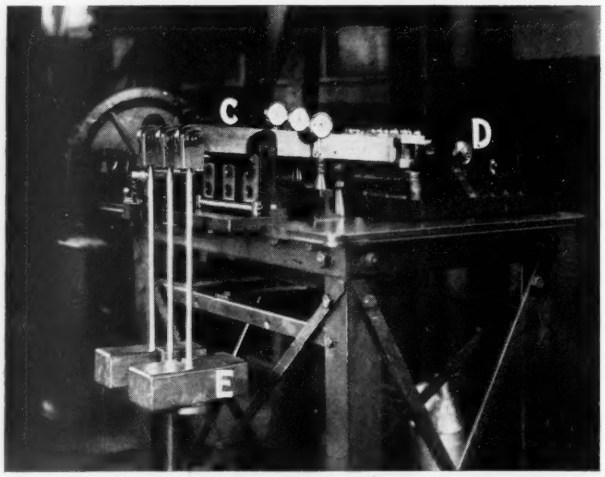


Fig. 4. — General view of Wear Testing Machine. * * *

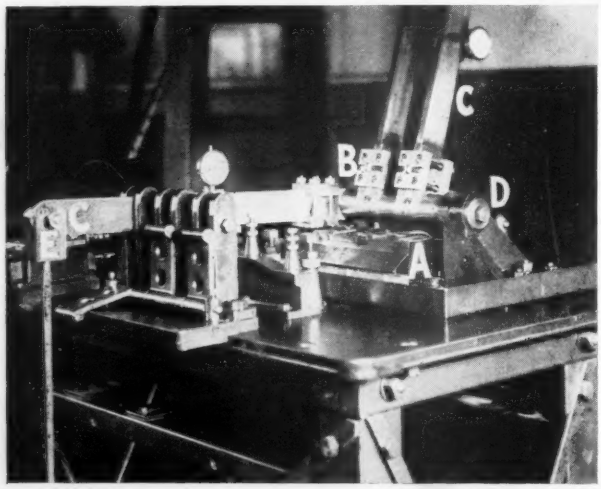


Fig. 5. — Wear Testing Machine showing lever carrying T.C. wearing nibs. * * * * * *

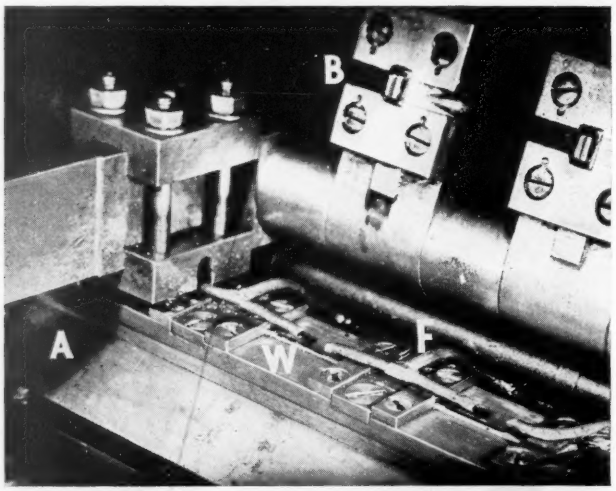


Fig. 6. — Details of arrangements for holding specimen and lubrication. * * * * * *

FOR example it was thought that a marked increase in carbon content might offer some assistance in resisting plastic wear in view of the known reduction in flow properties of such wire in wire-drawing. With lead patenting practice the gain in strength using such high carbon material is such as to render essential a marked reduction in the amount of cold work normally given to a wire in reducing it to its required size.

* * *

THIS was at first regarded with some apprehension as being a marked departure from standard practice and as it had the effect also of reducing the number of torsions normally called for, attempts were made to maintain the total reduction in drawing at a value round about 80% by raising the iso-thermal lead temperature from the normal 500°C, with a view to reducing the tensile strength of the patented rod.

* * *

IT was discovered that in order to maintain standard conditions in the drawing mills a lead quenched temperature of 590°C, was essential and although the microstructure of the rods quenched in this manner was not ideal it presented a marked improvement over the air patenting methods previously adopted. Fig. 3, illustrates the condition obtained from patenting treatment of this nature and although there are traces of residual ferrite and pearlite the microstructure can be considered reasonably good. This work was purely empirical but as time went on it became clear the considerable improvement was being effected in the lives of certain underground haulage ropes which had given repeated trouble due to rapid wear.

* * *

LARGE scale tests of this nature stressed the necessity for some reliable means of measuring the wear resistance of steel wires in the Laboratory if the many variables involved in the production of patent steel rope wire were to be investigated in a reasonable time. The complicating factor in large scale service tests is that the many variables inevitably present under the conditions of usage render a comparison of data from site to site quite impracticable. Some exploratory work was, therefore, put in hand to develop a method of testing for resistance to wear in which a machine was constructed with a hardened high speed steel wheel which was caused to rotate at the end of a weighted lever and bear against a specimen of wire. The speed of rotation of the wheel was in order of 500 RPM and most erratic results were obtained, mainly owing to difficulties associated with lubrication of contact faces and partly due to rapid wear of the wheel and oxidation of the specimens.

* * *

AS the result of many observations of haulage rope wear failures it had become evident that conditions of relatively slow surface movement under heavy loads were required and ultimately a testing machine was developed to simulate these conditions. Photographs of the machine are shown in Figs. 4, 5 and 6.

* * *

SHORT straight lengths of wire (W) are clamped to a solid base (A) which is oscillated with a stroke of 1 inch at a rate of 33 cycles per minute. A semi-circular wearing nib (B) is fixed to a steelyard (C) which is pivoted at (D) and a load is applied at (E) which, by multiplication through the lever, results in considerable surface pressure on the wire. Movement of the steelyard is measured by a .001″ and by sub-division to .0002″ 0001″ and by sub-division to .0002″. The lever has a multiplication of 5.5 and the machine is therefore capable of measuring changes in the order of .000035″. Three such units are arranged on the machine and every test can be run in triplicate. Lubricating oil is pumped through small tubes (F), the specimens being completely flooded with oil throughout the test. Provision is made for filtering the oil and collecting the particles of metal removed from the wire surface.

* * *

THE wearing nibs were originally constructed of hardened high-speed steel, but reproduceable results were difficult to obtain, owing to a slight change in surface condition during the test. The machine was next modified so that a piece of the same wire was used as a wearing member. After many experiments the scheme was abandoned; the wearing member wore at a greater rate than the specimen and tended to tilt slightly, exposing a sharp edge to the wearing face of the oscillating wire. Difficulty was also experienced in obtaining sufficient loading owing to the greatly increased contact faces.

* * *

IN the final form of the machine, the nibs have been constructed from old tungsten carbide wire-drawing dies, split longitudinally and brazed to steel supports. Only the outer surface of the die is used and this is readily lapped to a high polish. The surface of these nibs has remained unaffected throughout all tests so far conducted.

* * *

IN arriving at this form of test it was recognised that it would be quite impossible to simulate identical conditions operating to wear a wire rope in service. It was considered, however, that this wear was normally of such a type that variables such as the differences of contact metals, the nature or lack of lubricant could be usefully eliminated and in the form of tests shown these conditions have been achieved. One difficulty, not easy to overcome, was the uni-directional flow of surface films produced on continuous haulage-ways but as many haulage ropes operate by reversal of direction and show no noticeable difference in wear characteristics it was thought that the method of test arrived at would be satisfactory.

TABLE A

Acid Steel Carbon 0.73% — Manganese 0.56% — Diameter 0.119″.

Mark	Patenting	Total Red. in Drawing	Tensile	Torsions 100D	Bends 10 mm.
A.	Air	85% — 5 passes	117.0	35	14
B.	Lead	70½% — 5 passes	118.0	23	22
C.	Air	85% — 8 passes	112.0	41	18

Pilot Tests

HAULAGE wires in the 110/120 T/sq.in. tensile range were used for the exploratory tests. They were produced as shown in Table A.

* * *

SAMPLE "C" was drawn on single blocks exactly in accordance with earlier practice. "A" is the same base drawn five passes on continuous machines and "B" represents production for special haulage ropes to a low reduction in drawing. Each test was run in triplicate and identical results were obtained.

* * *

THE load was increased in three stages on account of increasing contact area due to wear. Curves showing the amount of wear plotted against lateral movements of the wires are shown in Fig. 7. These show that under the initial loading, wear proceeds rapidly, but the curves soon become asymptotic suggesting the production of a hard film capable of resisting further surface flow. On increasing the load, the curves show progressive flow and examination of the worn surface at the conclusion of the tests revealed extensive breakdown of the films in the air patented wires, in marked contrast to the final condition of the lead patented sample "B".

* * *

FIG. 8 shows the three wires after 8,000 cycles and illustrates clearly the remarkable breakdown and partial removal of the flowed films in samples "A" and "C" whereas in sample "B" the surface film is intact. The curves in Fig. 7. show this sample to be capable of withstanding a much higher load per unit area without breakdown.

* * *

THE appearance of these work-hardened and broken films is identical with that of many service failures which have come under review and the order of wear resistance shown by these initial tests is in complete accordance with results obtained in practice.

* * *

A satisfying feature of the exploratory tests was the reproduceability of results. The tungsten carbide wearing nibs remained unaffected and it was possible to repeat the tests at will and obtain identical figures.

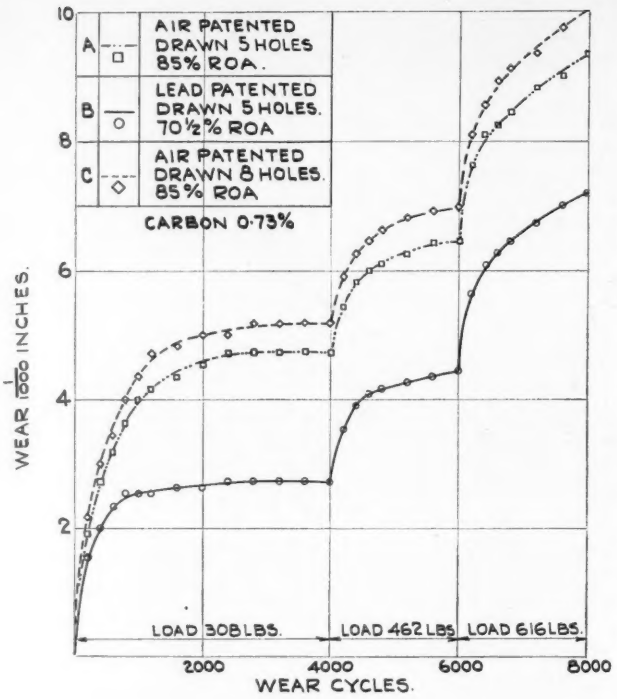


Fig. 7 — Curves showing rate of wear for three loads. * * *

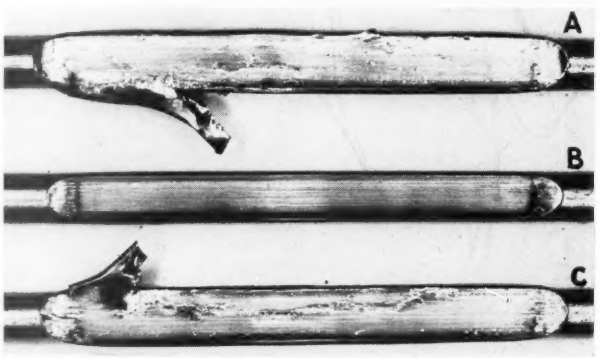


Fig. 8. — Surface conditions of three wires of identical tensile strength but differing in method of manufacture, after wear test. * * * * * *

Influence of Wire Manufacturing Variables

THE final tensile strength of drawn patent steel wire is controlled by major variables.

(a) Composition of steel.
(b) Method of Patenting.
(c) Total Amount of Cold Work.

* * *

THERE is, in addition, a minor variable of temperature during drawing. These conditions may be expressed as follows:

$$\frac{P u \Theta}{C(\text{Log.}W)}^{2} = K$$

Where K — Constant
Pu— U.T.S. of patented base.
W — Reduction of area in drawing, %
c — Carbon content, %
Θ — Temperature factor having a maximum of 1.0.

* * *

FROM this expression it will be seen that if the carbon content is increased, the total amount of cold work must be reduced if the ultimate tensile strength of the finished

* * *

wire is to remain constant. Similarly, variation in tensile strength due to different types of patenting must be compensated for by a reduction in either carbon content or total amount of cold work. The experimental work to be described has been conducted in order to investigate the influence of these variables on the wear resisting properties of wires for haulage ropes.

TABLE I

Air Patented.	Physical Properties.		
Mark	U.T.S.	Torsions 100 diams.	Bends over 10 mm.
R. 27			
R. 43	83.1	35	15
R. 5	92.0	38	16
R. 55	94.0	38	15
R. 65	102.3	39	17
R. 7	110.5	35	14
R. 8	120.1	37	15

TABLE II

Wear Tests			Air Patented		Weight lost at
Mark	Wear Cycles:—	4000	6000	8000	8000 cycles.
	Load lbs:—	308	462	616	Grams.
R. 27	No resistance to wear			All samples	
R. 43	do			worn through	
R. 5	do			at 4,000	
R. 55	do			cycles.	
R. 65		.0105	.0141	Worn through	
R. 7		.0056	.0086	.0127	.0125
R. 8		.0041	.0065	.0094	.0075

TABLE III

Lead Patented at 500°C.	Physical Properties.		
Mark	U.T.S.	Torsions 100 diams.	Bends over 10 mm.
R. 27	76.0	39	15
R. 43	89.3	37	18
R. 5	102.0	38	17
R. 55	104.0	38	18
R. 65	120.0	24	18
R. 7	131.0	22	17
R. 8	149.5	12	14

TABLE IV

Wear Tests.		Lead Patented at 500°C.			
Mark.	Wear Cycles:—	4000	6000	8000	Weight lost at
	Load lbs:—	308	462	616	8000 cycles Grams.
R. 27.		.016.	—	—	
R. 43.		.014	—	—	
R. 5.		.0077.	.0105	.0158.	.0353
R. 55.		.0073	.0099	.0139	.0263
R. 65.		.0042.	.0056.	.0080	.0088
R. 7.		.0035.	.0049	.0066.	.0055
R. 8.		.0021	.0031	.0049.	.0033.

TABLE V

Lead Patented at 590°C.	Physical Properties.		
Mark.	U.T.S.	Torsions 100 diams.	Bends over 10 mm.
R. 65.	110.0.	30.	17
R. 7.	119.5.	29.	17.
R. 8.	128.0.	22.	16.

Wear Tests.		Lead Patented at 590°C.			
Mark.	Wear Cycles:—	4000	6000	8000	Weight lost at
	Load lbs.:—	308	462	616	8000 cycles.
R. 65		.0057.	.0083.	.0121.	.013 grs.
R. 7.		.0053.	.0073.	.0099.	
R. 8.		.0042.	.0057.	.0083.	.0096

Influence of Carbon Content

BASIC Steel Rods of increasing carbon contents were selected having the following analyses:

Mark	Carbon %	Manganese %
R. 27	.27	.74
R. 43	.47	.60
R. 5	.53	.67
R. 55	.56	.61
R. 65	.65	.70
R. 7	.72	.66
R. 8	.80	.69

* * *

THEY were drawn to a constant base size, welded into continuous lengths and patented through lead both at 500° C and 590° C. A further series was air patented. Three lengths of patented rod were in this manner obtained containing all the above carbon steels in the three patented conditions.

* * *

THE three lengths were subsequently drawn on 5 hole machines (water-cooled blocks) by a standard reduction in area of 80%. By this means, two manufacturing variables — method of patenting and carbon content — were obtained, cold work and drawing temperature being constant. The final diameter was 0.120″.

* * *

SPECIMENS selected from these lengths of wire were separated and subjected to wear on the testing machine as described in the experimental procedure.

* * *

THE physical properties and wear test results are tabulated (Tables I - IV) the figures for wear being given both in loss in diameter in inches at the loads shown and loss in weight of the specimen at 8,000 cycles.

* * *

IT will be observed that the lower carbon wires exhibit complete and continuous wear at quite low contact loads. The air patented wires are particularly poor in wear resistance and not until the higher carbon wires are reached is it possible to record any results at the range of loads adopted for the tests.

* * *

PATENTING in lead at 590°C. was carried out in order to exploit the use of very high carbon wires, whose tensile strengths are too high when drawn the standard reduction of 80% from bases patented at the optimum temperature of 500°C. Tests were therefore only carried out on the highest carbon wires. (Table V).

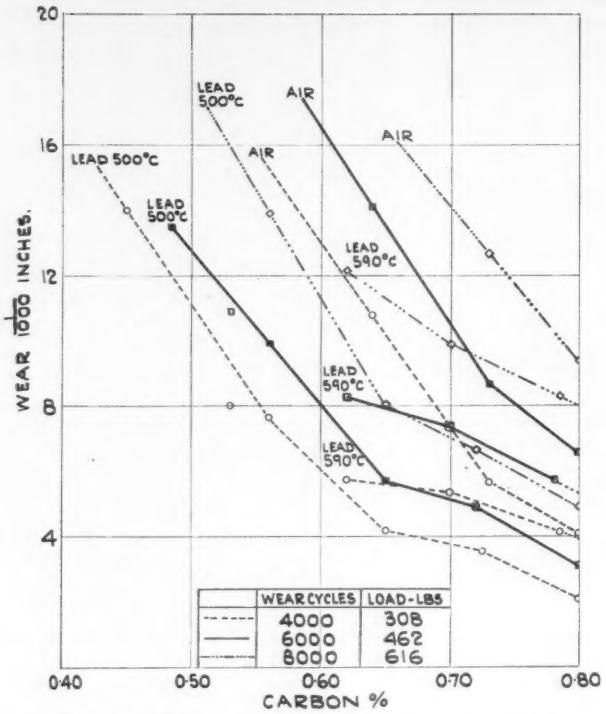


Fig. 9. — Rate of wear for increasing carbon content and different methods of patenting. ★ ★ ★ ★ ★

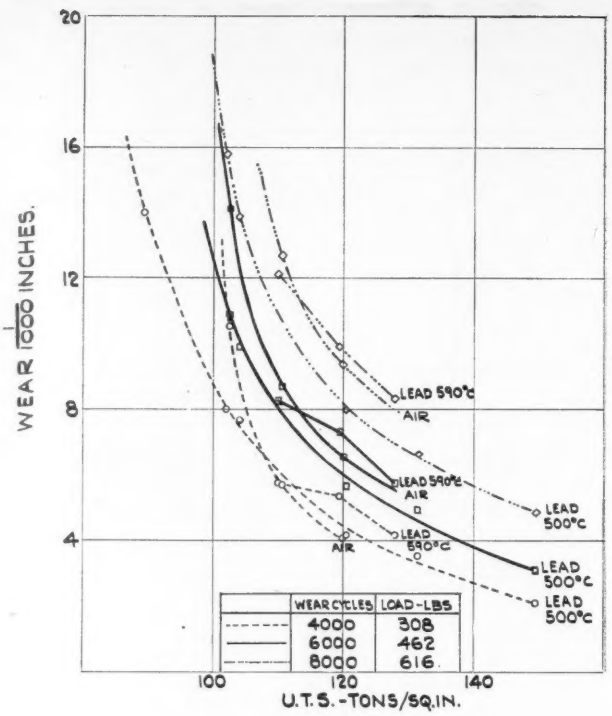


Fig. 10. — Rate of wear with increasing tensile strength. ★

THESE results are shown graphically in Figs. 9, 10 and 11. Inches of wear is plotted against carbon content for the three different methods of patenting in Fig. 9. The curves take the same general form for the three loadings and it is sufficient for comparison to observe the curves at 8000 cycles which have been plotted as full lines. The superiority of lead patenting at 500°C. is clearly shown and the air patented series are much inferior. As might be expected, the wear curves for the 590°C. lead treatment lie roughly in an intermediate position.

★ ★ ★

FIG. 10. shows the same tests plotted against tensile strength and as the amount of cold work is constant the increase in tensile strength is due entirely to increase of carbon content. The curves are now exceedingly smooth and below 100 T/Sq.in. all the wires are shown to wear at a high rate. The only wires which proved satisfactory at low tensile strengths under the conditions of test were those produced from bases patented at 500°C., this treatment appearing to have a stabilizing effect.

★ ★ ★

UNDER these conditions the highest carbon wires produce unduly high tensile strengths suggesting recourse either to quenching at higher temperatures or drawing a smaller amount.

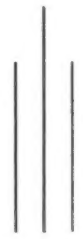


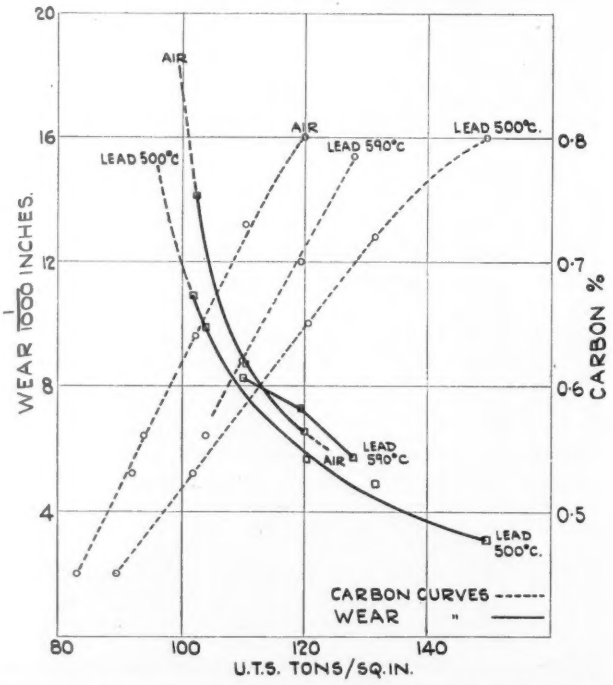
Fig. 11. — Curves showing relation between tensile strength carbon content and rate of wear for one loading. ★ ★ ★ ★ ★

★ ★ ★

THE shape is the same for all three loadings and for purpose of clarity in presentation of the results only the wear at 6000 cycles and 462 lbs. load are reported in the subsequent work.

★ ★ ★

FIG. 11. shows the 6000 cycle curves abstracted from Fig. 10



over which are plotted curves showing the increase in tensile strength with carbon content for the three methods of patenting. It is possible from this figure to place the wear results in a better perspective, for example using the tensile curves, shown dotted, at 120 T/Sq.in. U.T.S. patenting in lead at 500°C., 590°C. and air patenting are found to require carbon content of 0.65%, 0.70% and 0.80% respectively. The very high carbon content of the air patented wire yields a better resistance to wear than the 0.70% carbon patented at 590°C. in lead but inferior results to the 0.65% carbon steel patented in lead at 500°C. It is, therefore, established that iso-thermal cooling in lead at 500°C. induces a marked increase in wear resistance.

Influence of Cold Work

TEST lengths of each of five steels were welded together in various base sizes, which when drawn to the final size of 0.120" diameter yielded reductions in drawing of 71.5%, 75%, 80%, 85% and 88%. In order to remove one variable they were all patented through lead at 500°C. and drawn 5 holes on water-cooled block continuous machines with the exception of the 88% reduction which received one additional pass. By this means a series of samples of increasing cold work were obtained in each of 5 carbon contents and in constant size. The rods selected for these tests had the analyses: (Shown this page).

* * *

PHYSICAL properties and wear results are tabulated in Tables VI - X.

* * *

THE final surface condition of these test pieces is shown in Fig. 12. The extent of wear is considerable and the cold-worked film is seen to be breaking up into small thin flakes. The breakdown is slightly worse in the heavier reductions.

* * *

FIG. 13. shows the final condition of the surface of the test pieces. The fine flake breakdown is again noticeable, but the last three reductions show severe breakup of the film.

FIG. 14. shows a marked improvement in the flowed film, but again the last two reductions have broken up badly.

Mark	R.43	R.5	R.6	R.7	R.8
Carbon %	0.47	0.50	0.61	0.72	0.81
Manganese %	0.66	0.66	0.65	0.65	0.70

TABLE VI

R. 43	71.5%	75%	80%	85%	88%
U.T.S. t/sq. in.	89.0	92.0	96.5	106.5	114.5
Torsions 100D.	40	46	34	30	31
Bends 10 mm.	23	19	20	11	14
Wear loss, inches/6000 cycles	0.0184	0.014	0.0135	0.0117	0.00808
Wear loss, grs/8000 cycles	0.0846	0.0492	0.0570	0.0475	0.0580

TABLE VII

R.5.	71.5%	75%	80%	85%	88%
U.T.S. t/sq. in.	93.1	95.6	100.8	111.5	117.0
Torsions 100D.	43	45	45	33	26
Bends 10 mm.	21	21	18	18	13
Wear loss, inches/6000 cycles	0.01255	0.0109	0.0109	0.0093	0.0073
Wear loss Grs/8000 cycles	0.0342	0.0284	0.056	0.0482	0.0478

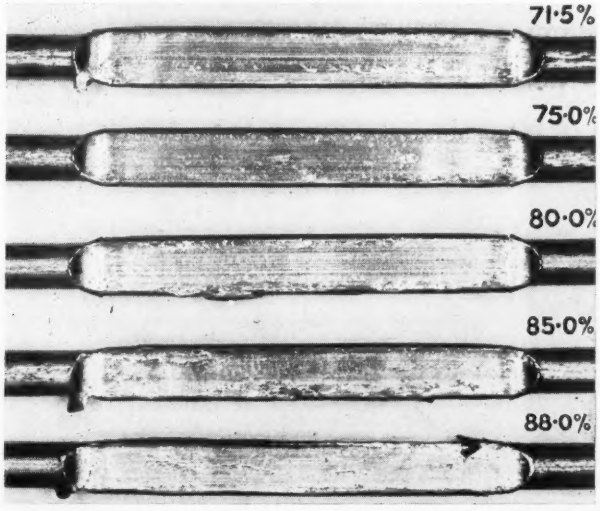


Fig. 12. — 0.47% carbon wires drawn by increasing amounts of cold work. Condition of worn surfaces. X3

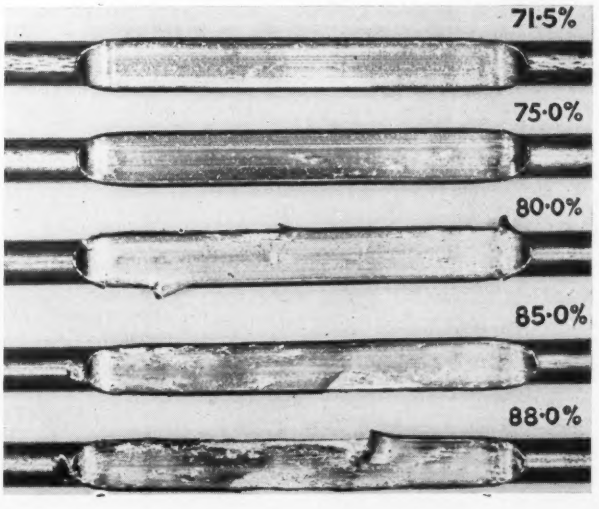


Fig. 13. — 0.50% carbon wires drawn by increasing amounts of cold work. Condition of worn surfaces. X3

FIG. 15. shows that smooth wearing properties have been effected by this increase of carbon content. The first two reductions have broken slightly.

* * *

FIG. 16. shows the appearance of the surfaces of this final set of test pieces.

TABLE VIII

R.6.	71.5%	75%	80%	85%	88%
U.T.S. t/sq. in.	102.0	107.0	114.5	123.0	133.0
Torsions 100D.	33	34	29	26	21
Bends 10 mm.	22	20	18	17	14
Wear loss inches/6000 cycles	0.0078	0.0078	0.0066	0.0058	0.0055
Wear loss grs/8000 cycles	0.0232	0.0232	0.0104	0.0070	0.0070

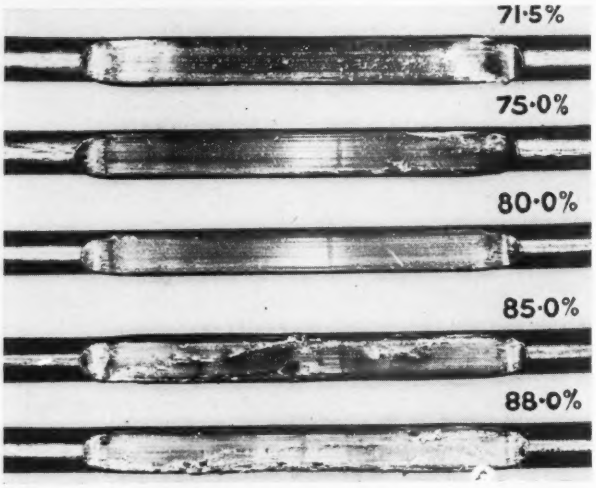


Fig. 14. — 0.61% carbon wires drawn by increasing amounts of cold work. Condition of worn surfaces. X3

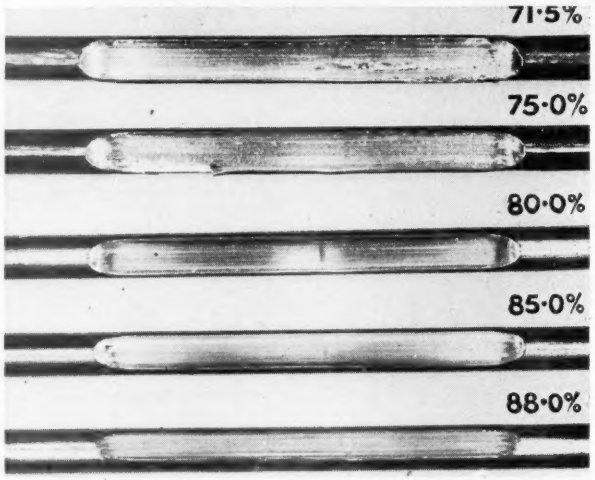


Fig. 15. — 0.72% carbon wires drawn by increasing amounts of cold work. Condition of worn surfaces. X3

* * *

THE loss in section values are plotted in Fig. 17 and loss of weight figures in Fig. 18. In both figures the increase in tensile strength due to cold work has been plotted against the equivalent reduction, the curves being shown as broken lines. It is possible to use these composite diagrams to observe the relative importance of carbon content and reduction of area in the following manner:

* * *

FOR any given tensile strength of wire shown on the right hand side of the figures a horizontal reference will cut two or more of the broken curves representing the carbon content of the wire. Reference to the reduction area at the point of intersection will show the amount of wear, taken from the left hand scale. For example, at 120 Tons tensile the wire containing .60% carbon will wear 0.006″, .70% carbon—0.0055″, and 0.80%—0.0056″. Fig. 19 can be interpreted in a similar manner.

* * *

TABLE IX

R.7.	71.5%	75%	80%	85%	88%
U.T.S. t/sq. in.	111.5	114.5	132.2	145.0	152.5
Torsions 100D.	41	31	22	21	11
Bends 10 mm.	20	19	18	16	8
Wear loss inches/6000 cycles	0.0070	0.0058	0.0045	0.0040	0.0025
Wear loss Grs/8000 cycles	0.0160	0.0116	0.0080	0.0074	0.0038

TABLE X

R.8.	71.5%	75%	80%	85%	88%
U.T.S. t/sq. in.	120.0	124.2	139.8	150.2	157.0
Torsions 100D	29	32	20	2	4
Bends 10 mm.	18	18	17	10	8
Wear loss inches/6000 cycles	0.0056	0.0049	0.0039	0.0025	0.0023
Wear loss grs/8000 cycles	0.0084	0.0090	0.0058	0.0022	0.0031

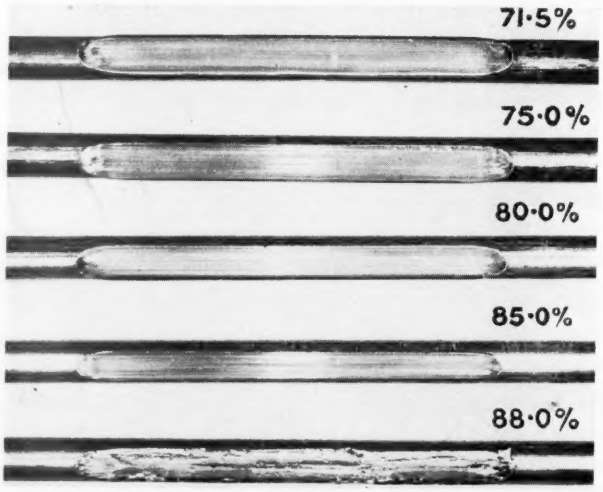


Fig. 16. — 0.81% carbon wires drawn by increasing amounts of cold work. Condition of worn surfaces. X3

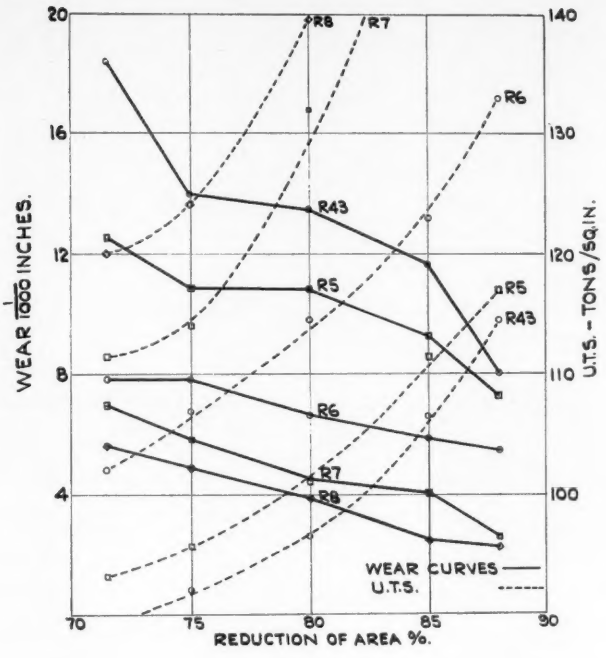


Fig. 17. — Rate of wear with increasing cold work for various carbon contents. * * * * * *

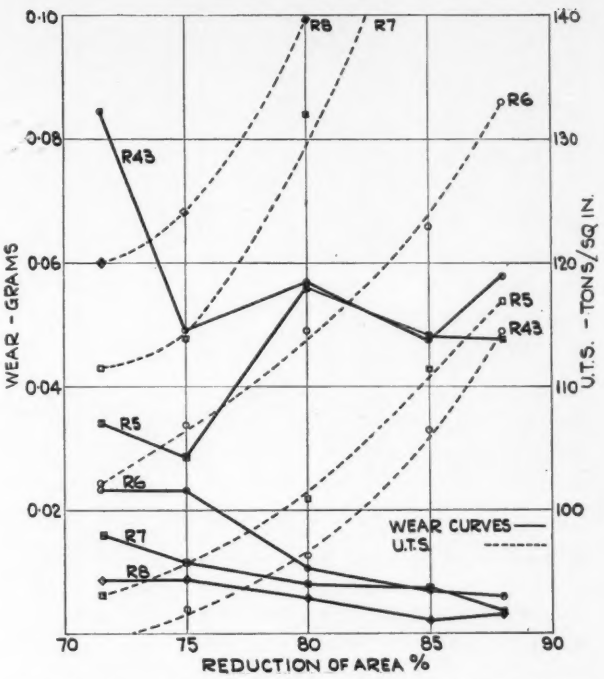


Fig. 18. — Loss in weight due to wear for various carbon contents.

BOTH figures show the comparative unimportance of heavy drawing on the wear properties. The curves bring out in a forcible manner the great influence of carbon content both in inducing stability to the wear curves and very materially increasing the resistance to plastic flow. The sharp rise of the tensile curves has produced no corresponding fall in wear loss where tensile rise is due solely to cold working. This is emphasized by replotting the loss in weight figures against tensile strength as

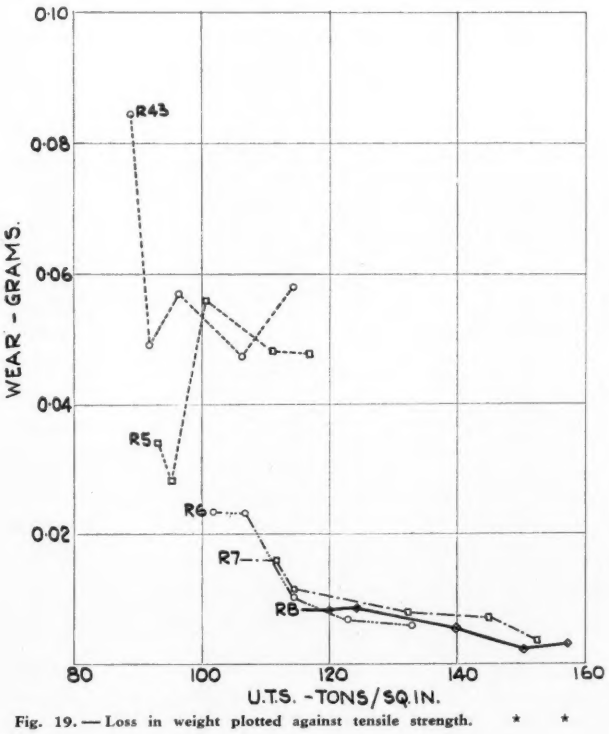


Fig. 19. — Loss in weight plotted against tensile strength. * *

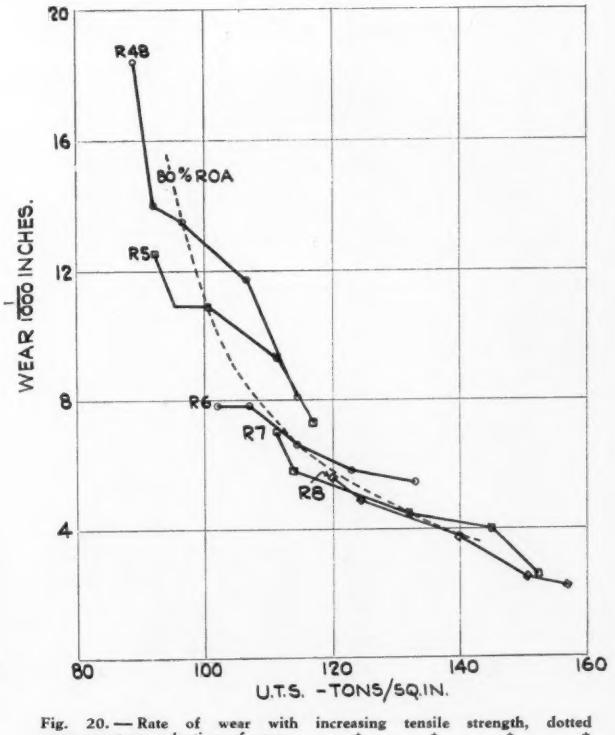


Fig. 20. — Rate of wear with increasing tensile strength, dotted curve constant reduction of area. * * * *

Fig. 21. — Fractures in flowed film on 0.47% carbon wire. X 100

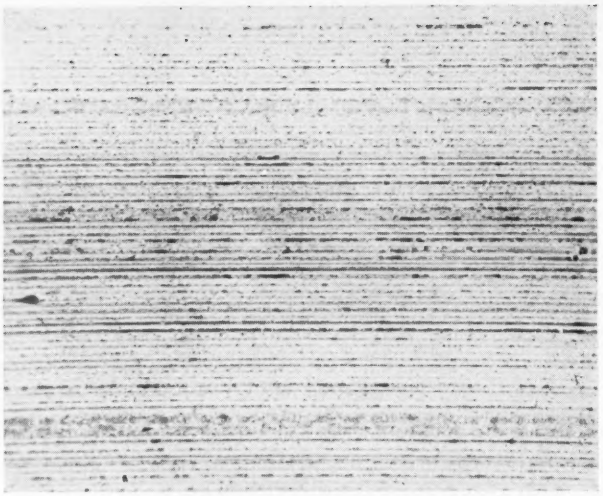


Fig. 22. — Smooth film on 0.81% carbon wire. X 100

in Fig. 19. The big reduction in weight loss with increasing carbon content is in marked contrast to the small improvement effected by increasing the tensile strength by cold work.

* * *

CURVES connecting the dimensional wear losses with tensile strength are shown in Fig. 20 to be of an irregular character. When points of constant reduction of area in drawing are interconnected, regular curves are obtained. One such curve is shown dotted on Fig. 20. The other values plot similarly but have been omitted for the sake of simplicity.

* * *

THE connected curve as derived in this manner will be seen to be identical with the curves of Figs. 10 and 11 with which it is complementary. Striking confirmation is thus obtained that wear properties are directly related to tensile strength derived from the carbon content of the steel. Confirmation is also obtained of the validity of the method of testing, identical curves being derived from two separate and distinct sets of test pieces.

The Mechanism of Plastic Wear

DURING the progress of this research, some interesting observations have been made regarding the behaviour of surface flowed films when subjected to continuous heavy plastic wear. A marked difference has been noticed between wires which wear rapidly and wires which show satisfactory resistance. In the first case, the superficial layer of the cold worked film appears to possess very poor strength and is continually breaking down and being removed in the form of large thin flakes. Fig. 21 shows the surface of one of the lower carbon lead patented wires after being subjected to a considerable amount of wear. This should be compared with the surface of one of the highly resistant high carbon wires shown in Fig. 22. In the latter case, the

Fig. 23. — Flakes of severely cold worked metal removed from wire of Fig. 22. X 100

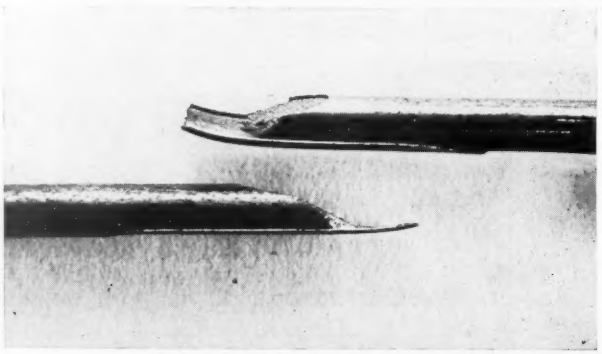


Fig. 24. — Typical cold worked film fractured by bending. X 3½

breakdown nuclei are minute and the flakes removed from this surface are in consequence small. Fig. 23 is a photograph of some of the flakes removed from the wire shown in Fig. 21.

* * *

ATTEMPTS have been made to determine whether the film removed in the form of flakes constitutes the whole of the cold-worked layer. Fracture tests of the worn out test pieces yield some evidence that the total cold worked layer may be of considerable thickness. Fig. 24 is a photograph of one of the high carbon lead patented wires which has been fractured by bending after the conclusion of a run on the wear testing machine. The burred over edges of the worn surface film is shown to be of substantial thickness. On the lower carbon wires similar fractures indicate that the cold work layer is thinner due to the continuous removal of the surface in the form of cold worked flakes. In the case of the high carbon wires the build up of a relatively thick highly resistant section on the worn surface appears to possess some advantage from the point of view of resistance to wear by further cold flow.

* * *

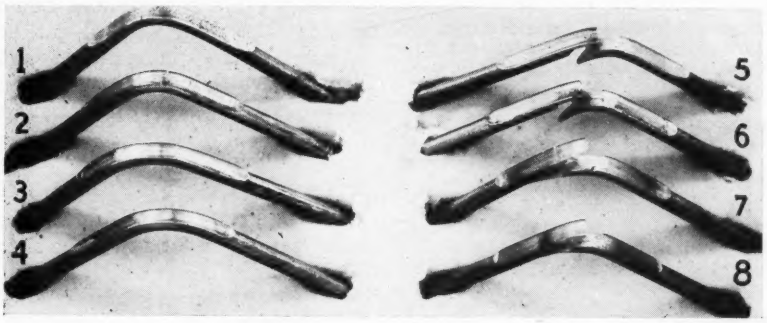


Fig. 25. (a) Lead patented. (b) Air patented.

Carbon.	0.56%.	1)	104.0 t/sq. in.	5)	94.0 t/sq. in.
"	0.65%.	2)	120.5 t/sq. in.	6)	102.3 t/sq. in.
"	0.72%.	3)	111.5 t/sq. in.	7)	110.5 t/sq. in.
"	0.80%.	4)	120.0 t/sq. in	8)	120.1 t/sq. in.

THE physical condition and ductile properties of the cold-worked layers and the underlying wire are obviously of the greatest importance, as haulage ropes in the main are subjected to arduous conditions of bending round pulleys and driving drums many hundreds of times during their lives. Where the film possesses a broken character and tends to be removed in large flakes as shown in the lower carbon series of photographs, fatigue cracks are bound to develop rapidly throughout the section.

* * *

A number of the worn test pieces have been bent over standard radii of 5 and 7.5 mm., in order to observe differences in the film strength. It has been found that in the air patented series, all worn surfaces crack and the wires break on bending once through angle of 90° over both 5 and 7.5 mm. Wires from the lead patented series withstand this test and show evidence of a marked improvement in ductile properties. Fig. 25 illustrates the two series of bend tests and the marked difference in behaviour needs no further comment. The two high carbon lead patented wires have been produced with a lower total reduction of area in order to maintain the tensile strength within reasonable limits. These wires have been found to possess particularly thick cold-worked films, despite which the ductility is shown to be very high when bent.

Note on Martensite Formation

MARTENSITE is formed as a brittle, hard, constituent when high carbon steel is raised to a temperature above the transformation point, then rapidly quenched. For many years a number of haulage rope failures have been found to occur due to the formation of a substantial film of Martensite on the worn flat surfaces of the outer wires. Owing to the extreme brittleness of this film it is impossible for the wires to be bent without the surface fracturing and many cases have been observed in which the Martensite layer had fractured in a direction normal to the axis of the wire.

* * *

FIRST reported by **Atkins** (1) its presence in rope wires was confirmed by **Pomp** (2) who proved that the Martensite film could be

(*Please turn to page* 1061)

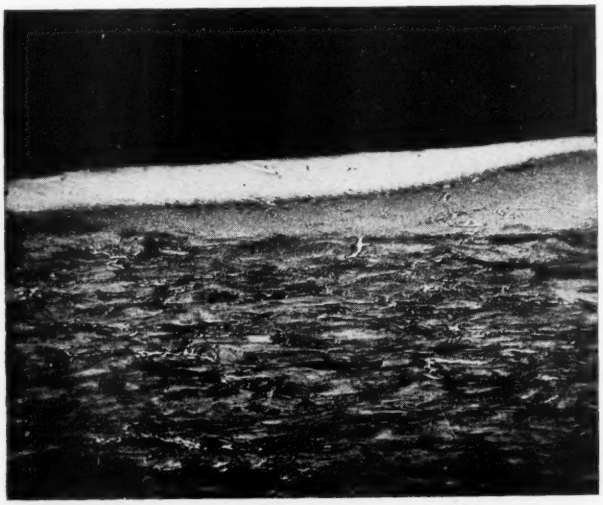


Fig. 26. — Martensite Film on worn Haulage Wire. X 100

Evaluation of Pickling Inhibitors from the Standpoint of Hydrogen Embrittlement

II — ACID PICKLING OF CARBON STEEL*

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SUMMARY

Second in a series of three papers exploring the relationships of pickling inhibitors and hydrogen embrittlement, the present discussion specifically concerns the pickling of mild steel in sulfuric acid.

* * *

Fifteen reagents are studied, including thirteen of the most widely used commercial inhibitors, one inhibitor base, and one reagent specially designed to prevent embrittlement.

* * *

While a severely deleterious effect of the inhibitors does not commonly display itself with mild steel as it does with stainless steel, seven of the reagents studied failed to prevent embrittlement regardless of either their concentration in the solution or their repression of metal attack; four others failed to prevent embrittlement within their proprietary ranges, though they did so at extra-proprietary concentrations; and four reagents satisfactorily prevented embrittlement throughout their proprietary ranges.

* * *

Of these latter four acceptable inhibitors, only the specially designed reagent likewise represses embrittlement during the pickling of stainless steel. The remaining three are equally satisfactory for mild steel, but are unsatisfactory for stainless steel.

* * *

Besides the practical aspects of the study, some attractive theoretical problems are indicated in explaining the surprising independence of embrittlement, with respect to metal attack, and the strongly adverse effect seeming to attach to the chromium content of the steel.

INTRODUCTION

IN the first article of the present series concerning pickling inhibitors[1], the constant-rate single-bend test was applied to the specific problem of hydrogen embrittlement occurring in stainless steel during pickling in sulfuric acid. The work was inspired by an earlier investigation[2] which demonstrated that several commercial pickling inhibitors, in spite of the fact that they greatly reduced metal attack, and hence the quantity of hydrogen developed, caused an **increase** in hydrogen embrittlement beyond that resulting from pickling in the raw acid itself.

* * *

HOWEVER, the original work concerned only a few selected inhibitors, and only the pickling of stainless steel. Two major questions were left unanswered: (1) Are the results common to all commercial reagents? and (2) Are the results applicable to mild as well as to stainless steel?

* * *

IN the foregoing paper[1], the first question was answered by a thorough study of sixteen reagents applied to the pickling of stainless steel in sulfuric acid. The present paper is addressed to the second question — the pickling of mild steel.

Paper I was published in the October 1948 issue of Wire & Wire Products, and Part III will be published in the December 1948 issue.

PARTICULAR interest attaches to the present study for the practical reason that the greatest pickling tonnage by far concerns unalloyed steel, and it is for these steels that the inhibitors have been designed. If the inhibitors behave in general as they do in pickling stainless steel — **increasing** damage from absorbed hydrogen — it is a matter of considerable practical consequence.

* * *

IF they do **not** behave in like manner, a strong theoretical interest develops; for, so far as can be determined, only one manufacturer of inhibitors has previously regarded the composition of the steel as a primary factor in inhibitor selection. These reagents are commonly added to the bath on the basis of the type and concentration of the acid used, not the steel.

* * *

OF secondary interest is the possibility of proving for the pickling of carbon steel, as was done for stainless steel, that the absorption of hydrogen concerns a subtle surface function which is so independent of the total quantity of hydrogen produced that one cannot predict the incidence of embrittlement on the basis of metal attack. With stainless steel, embrittlement often **increased** regardless of greatly decreased metal attack. Undoubtedly the previous lack of recognition of this unexpected relationship has frequently led to an erroneous conclusion that the reduced metal attack provided by inhibiting reagents prevents or minimizes problems from hydrogen absorption.**

* * *

TABLE I
Description of Plain Carbon Steel Specimens

S. A. E. Type	Analysis	Condition
1020	C = 0.18 Mn = 0.60 Si = 0.17	No. 5-gage green rod drawn 6 holes to 0.062-in. ϕ Ult. Tens. Str. = 170,000 psi.

*From research conducted in the laboratory of the senior author in conjunction with a program on gas-metal studies sponsored by the Office of Naval Research.

**Pickling inhibitors are primarily designed, as the reader knows, to reduce metal attack and acid loss. The present study in no way concerns an evaluation of the inhibitors on the basis of these two most important aspects, but ONLY on the basis of a third less prominent and less recognized aspect—hydrogen embrittlement.

Experimental Method

FOR experimental details, the reader is referred to the preceding paper[1]. Here the inhibitors shall only be referred to as Reagent I, II, III, etc. All listed in the preceding paper were used in the present study except Reagent XVI, which is a special new reagent designed specifically for stainless steel. The acid is again 10% by volume of c.p. H_2SO_4 in distilled water, the solution being renewed for each individual test. Pickling period is 15 minutes; temperature 77°C (170° F). Duplicate wire specimens were used, showing on the plots as large and small circles, respectively. Tests were limited to a single typical grade of mild steel described in Table I.

* * *

AT the introduction of each series, a "blank" was run. Its value is shown at the left of the graph on the ordinate. This is the angle of bend sustained by the wire after the 15-minute pickling period in uninhibited acid. The course of subsequent points to the right then reveals the effect of increasing additions of the particular reagent on embrittlement as measured by the angle of bend.

* * *

SINCE the original wire bends 180 degrees without breaking, but only 60 degrees after pickling in raw acid, the "area of embrittlement" to be conquered by the perfect inhibitor is the entire shaded area on each plot. The area actually won is indicated by light shading; the remaining area by heavy shading. An increase in embrittlement is indicated in solid black. The respective effects of the various reagents can thereby be readily compared visually.

RESULTS

AS in the pickling of stainless steel, the results from the present tests can be arbitrarily grouped in three classes:

I. Reagents which fail to repress embrittlement

II. Reagents which repress embrittlement only at extraproprietary concentrations

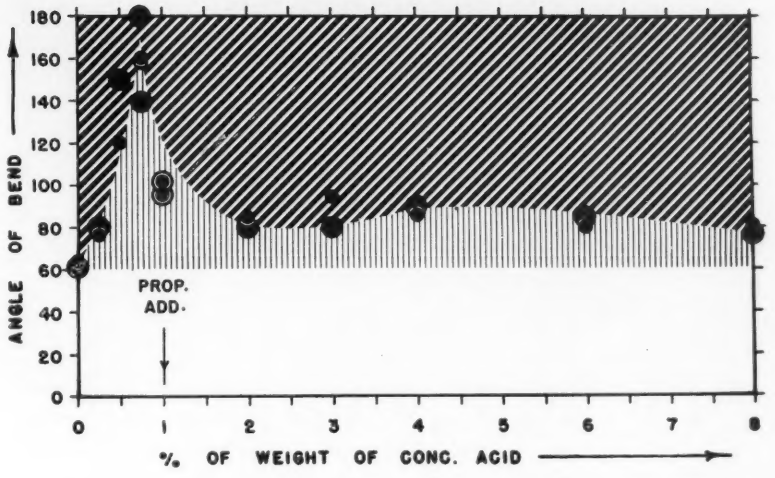

Fig. 1. — Behavior of Reagent I, showing incomplete repression of embrittlement. * * *

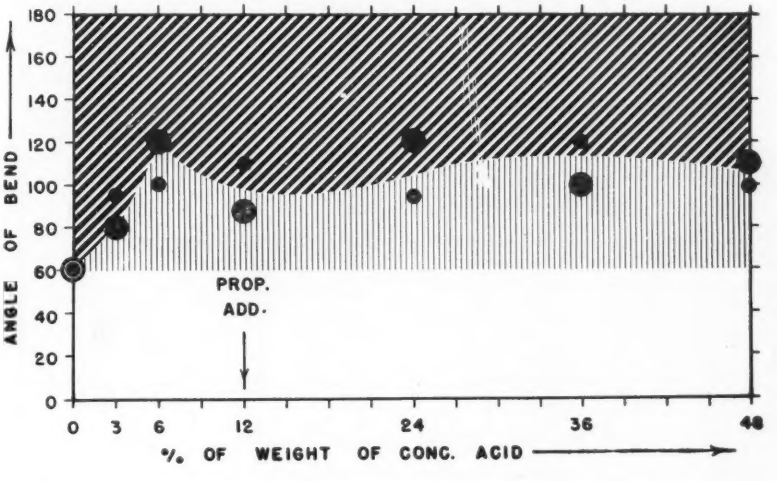

Fig. 2. — Behavior of Reagent IV, showing incomplete repression of embrittlement. * * *

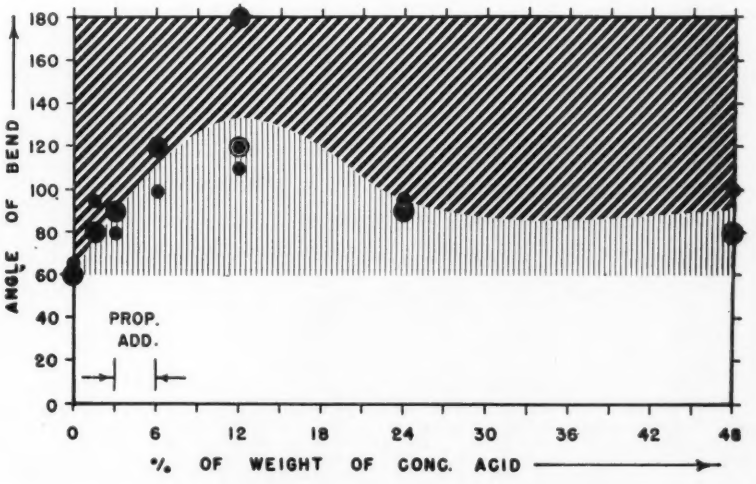

Fig. 3. — Behavior of Reagent V, showing incomplete repression of embrittlement. * * *

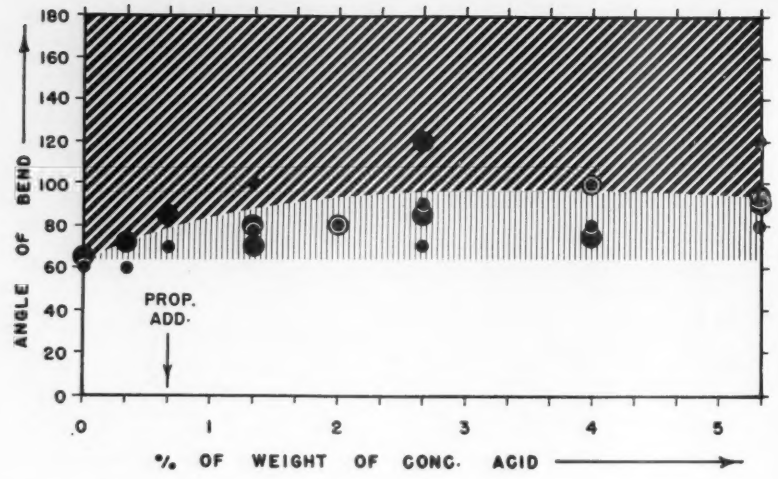

Fig. 4. — Behavior of Reagent XI, showing incomplete repression of embrittlement. * * *

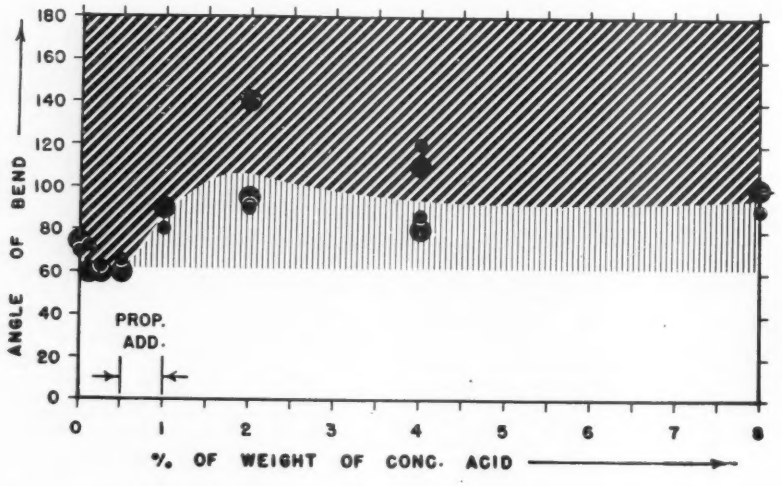

Fig. 5. — Behavior of Reagent VI, showing incomplete repression of embrittlement, with no effect at all of early additions. * * * * * *

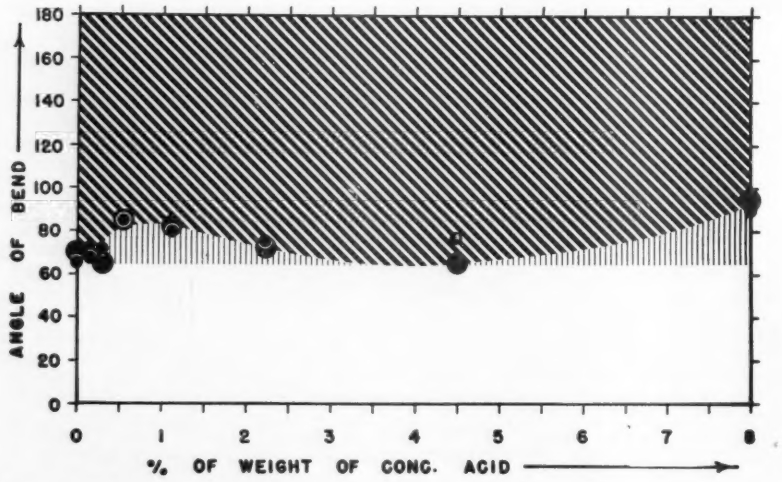

Fig. 6. — Behavior of Reagent VIII, showing virtually negligible repression of embrittlement.

III. Reagents which repress embrittlement throughout their proprietary ranges

* * *

HOWEVER, these are not the same three classifications used for the stainless steel, for the behaviors of the unalloyed and the alloyed steels differ importantly.

* * *

ALSO, emphasis must be given again to the fact that designations of embrittlement here made are only applicable within the range of the test; and that the three classifications are only arbitrary, though offering reliable comparison with one another.

* * *

THAT is, the original wire bends 180 degrees without breaking, and Class II and Class III reagents bring the angle of bend back from 60 degrees to 180 degrees, Class III accomplishing this safely throughout the entire proprietary range. But the test does not tell us whether the wire in the second condition is **absolutely undamaged.** A minor degree of brittleness might still persist which escapes the sensitivity of the test. For purposes at hand, however, these more subtle changes can be neglected.

Reagents Which Fail to Repress Embrittlement

IN Figure 1, Reagent I discloses a typical activity for this group. The "blank" value near 60 degrees is distinctly improved by addition of the inhibitor, at one point even reaching 180 degrees of bend in a single specimen; **but the improvement is incomplete,** the values unanimously dropping near 100 degrees at the proprietary addition, and at greater concentrations falling to still lower values. The lightly shaded area, denoting improvement from addition of the inhibitor, is much less extensive than the heavily shaded area representing the failure to achieve the desirable accomplishment.

* * *

REAGENT IV in Figure 2 discloses a similar action, lacking the height of the early peak in Figure 1, but showing slightly better results with additions exceeding the proprietary. Nevertheless,

at no concentration, including a four-fold excess over the proprietary, is a bend of 180 degrees regained.

* * *

IN Figure 3, Reagent V shows much the same activity, attaining one single value of 180 degrees at a concentration considerably greater than the proprietary addition.

* * *

WHILE these three reagents show a rather marked upsweep of the curve with early additions, followed generally by a reversal to lower values, Reagent XI in Figure 4 shows a much slower improvement with less indication of a reversal.

* * *

IN Figure 5, Reagent VI even shows an absence of any improvement in early additions, though the subsequent behavior is similar to the preceding. No point will be made of the initial drop indicated from the blank because the blank in this case at 75 degrees is not consistent with all other determinations near 60 degrees.

* * *

REAGENT VIII, shown in Figure 6, is not strictly an inhibitor, but is instead an inhibitor-base for another reagent. No proprietary addition is therefore indicated. Its early behavior is much like that of Reagent VI; but it later leads to values which are virtually identical with the blank. It was included in the study in an attempt to isolate the efforts of major inhibitor constituents.

* * *

IN Figure 7, Reagent X actually increases embrittlement beyond that caused by the raw acid. Here, however, is the only instance of that activity with carbon steel — an activity which virtually characterizes most of these inhibitors when used with stainless steel.

Reagents Which Repress Embrittlement Only at Extra-Proprietary Concentrations

WHILE the foregoing seven reagents never at any concentration regain for the specimen an angle of bend of 180 degrees, those

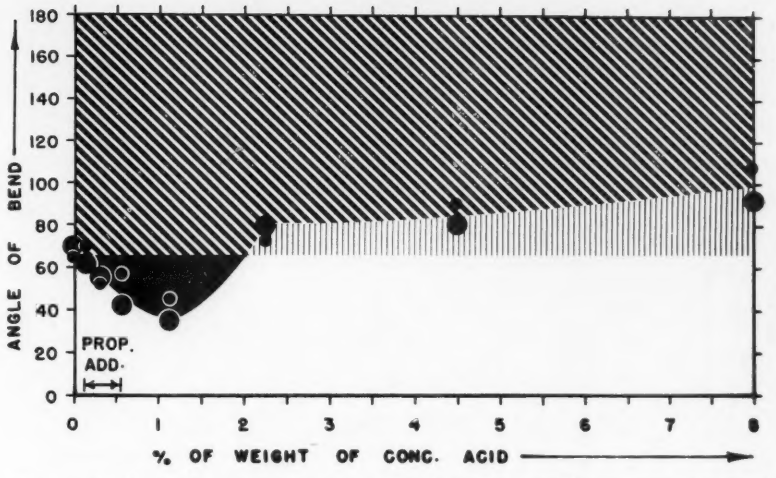

Fig. 7. — Behavior of Reagent X, showing an actual increase of embrittlement beyond that caused by raw acid, followed at higher concentrations by a slight embrittlement. * * *

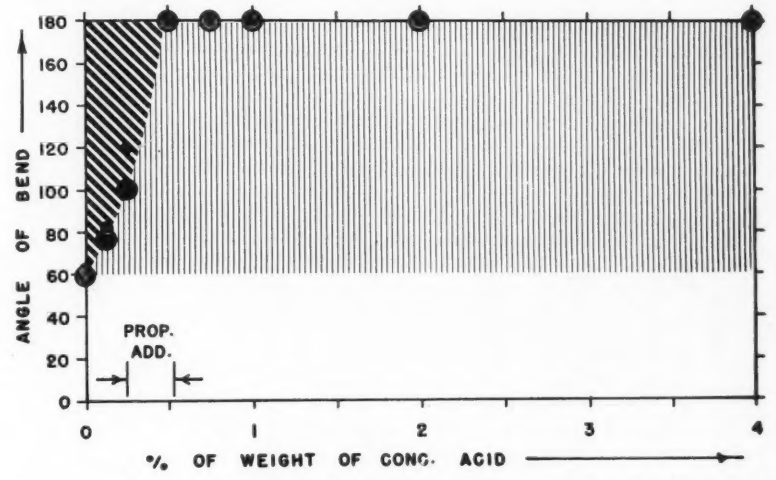

Fig. 8. — Repression of embrittlement attained by Reagent XII, but only in the high range of the proprietary addition. * * * * * * * * * *

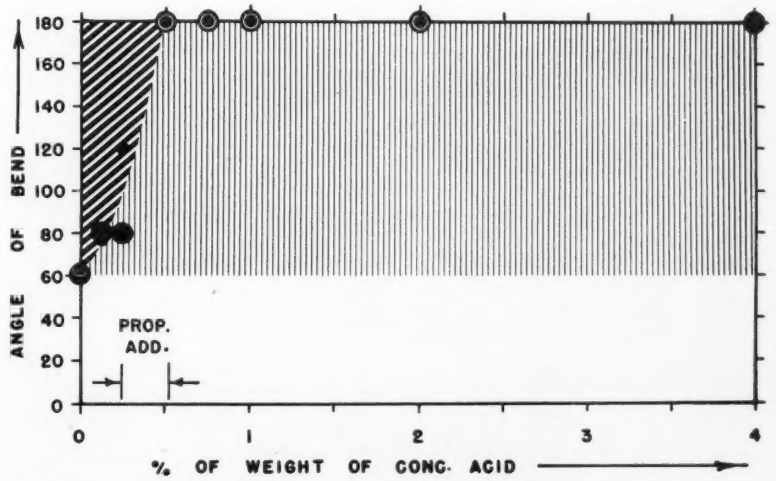

Fig. 9. — Repression of embrittlement attained by Reagent XIV, but only in the high range of the proprietary addition. * * * * * * * * * *

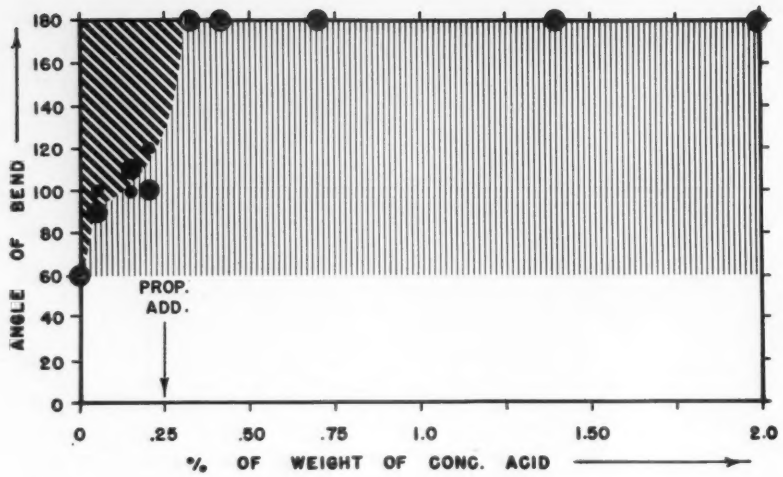

Fig. 10. — Repression of embrittlement by Reagent II, but only at extra-proprietary additions.

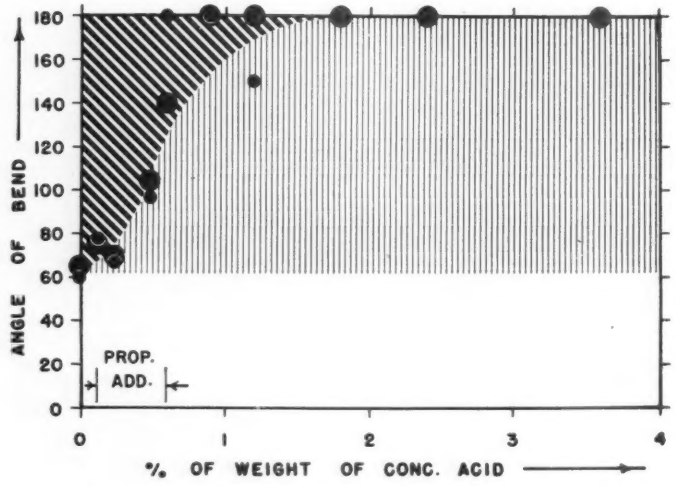

Fig. 11. — Repression of embrittlement by Reagent VII, but only at extra-proprietary additions.

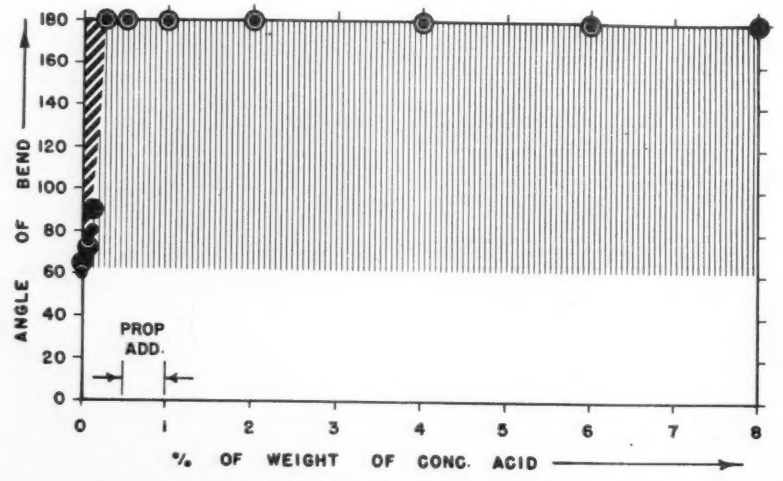

Fig. 12. — Reagent III, an inhibitor of hydrogen embrittlement. * * *

remaining to be discussed do bring the angle of bend completely back, so far as the present criterion is able to show.

* * *

AMONG these, two groups can be arbitrarily distinguished. The first comprises four reagents, each of which represses embrittlement, but not dependably within the proprietary range.

* * *

IN Figure 8, Reagent XII discloses a typical activity, the angle of bend rising steeply from the blank, but just regaining 180 degrees in the high range of the proprietary addition.

* * *

REAGENT XIV in Figure 9 shows an almost identical behavior; and these two reagents are the best in this second group. Kept on the very high side of the proprietary concentration, either of them will repress embrittlement; but the advantage is rapidly lost at lesser concentrations.

* * *

EMPHASIZING somewhat further the general undependability of this second group from the standpoint of embrittlement, Figure 10 shows recovery in the presence of Reagent II to culminate at concentrations slightly greater than proprietary. Thus, a very slight change in the concentration of this reagent one way or the other from the proprietary can change the condition of embrittlement from complete repression to fracture at 100 degrees of bend.

* * *

IN Figure 11, Reagent VII shows itself to be the least beneficial of the group. Full repression is effected, but only at concentrations considerably greater than proprietary. Within the recommended range, the effect varies from virtually no improvement at all in the low range up to a sporadic attainment of a 180-degree bend at the upper limit.

Reagents Which Repress Embrittlement Throughout Their Proprietary Range

IN this last group are the only reagents among all studied which fulfill the requirement of repressing

hydrogen embrittlement. Four qualify, one of which is a specially developed reagent. To fully appreciate the effect they accomplish, one should compare the respective shaded areas of the following four figures with those of either of the two preceding groups.

* * *

REAGENT III in Figure 12 discloses such an immediate return to a 180-degree bend that the heavily shaded area almost disappears. The accomplishment is safely completed even below the minimum of the proprietary range.

* * *

REAGENT XIII in Figure 13 shows an identical effect, the shaded area only appearing greater than in the preceding figure because the horizontal scale has been doubled to display the lesser proprietary addition. Certainly this seems to be an admirable reagent, combining as it does a minimum proprietary addition for any in the group, along with a maximum repression of hydrogen embrittlement for any yet observed.

* * *

ONLY Reagent IX, shown in Figure 14, outclasses Reagents XIII and III on the basis of the present criteria. Embrittlement is repressed completely by such minute additions of this reagent that the minimum of the broad proprietary range is still severalfold higher than the concentration providing a 180-degree bend. It will be recalled from the earlier study that this inhibitor was the **only one of all tested** which effected any improvement at all in the pickling of stainless steel[1].

Development of a New Inhibitor

IN the preceding paper[1], two new inhibitors were studied which were specially developed in conjunction with the staff of the American Chemical Paint Company from the standpoint of repressing hydrogen absorption — Reagents XV and XVI. The latter, however, was designed specifically for the pickling of stainless steel and will not be discussed here.

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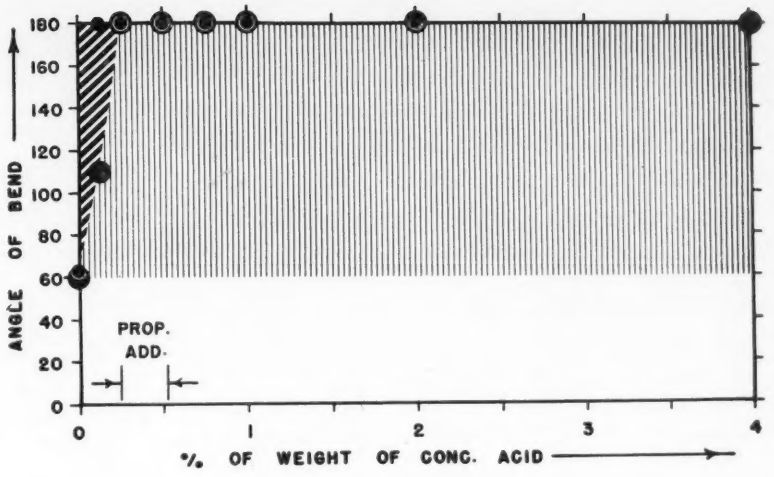

Fig. 13. — Reagent XIII an inhibitor of hydrogen embrittlement. * * *

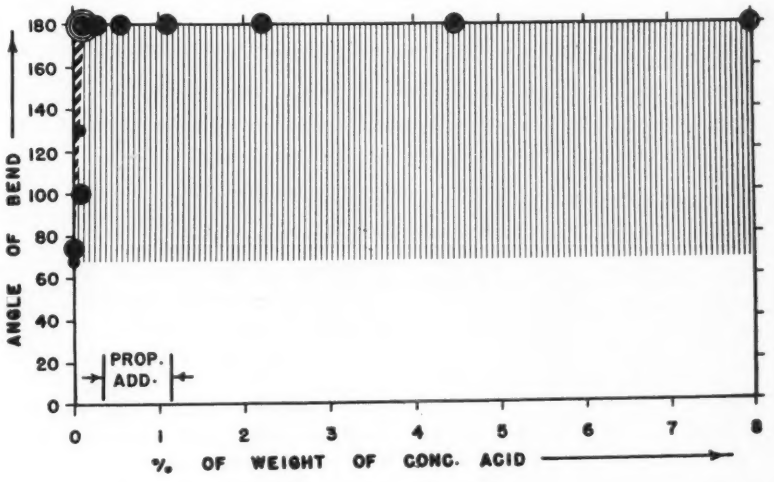

Fig. 14. — Reagent IX, an inhibitor of hydrogen embrittlement. * * *

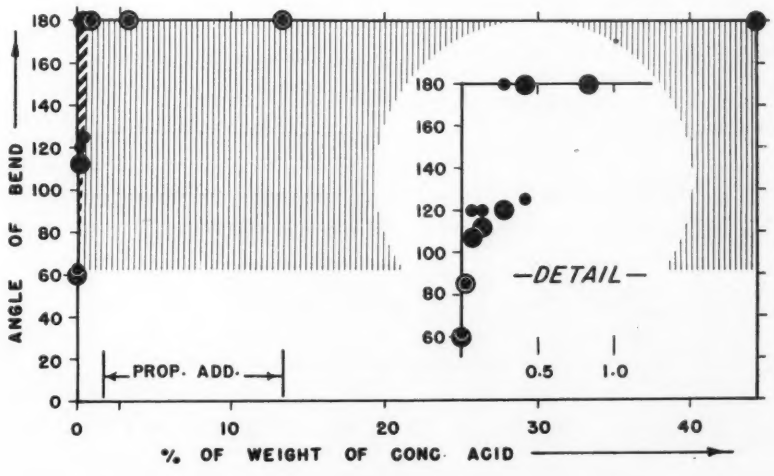

Fig. 15. — Reagent XV, specially developed for inhibiting hydrogen embrittlement. * *

The Handling of Webs and Monofilament Materials

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Industrial Ovens, Inc.
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PART I

A study of some primary considerations with respect to an entire operation involving flexible and continuous strand or web materials. Published in two parts. Part II will follow in the December issue.

SINCE the advent of synthetic and flexible coating materials and the related problems of their application to wires, cables, papers and fabrics, the continuous process handling of the materials has become an important engineering problem.

* * *

MUCH data has been recorded and many valuable papers have been published on the specific problems encountered in equipment design for unwinding or winding continuous flexible material. Some have been devoted exclusively to factors encountered in the selection of system drives, motor characteristics, torque or horsepower determinations, and as such have given much worthwhile data.

* * *

THIS writing, however, is purposely directed toward some primary considerations with respect to an entire operation involving flexible and continuous handling of continuous strand or web materials. The basis is purposely broad to show the similarity of a handling problem that is encountered in extrusion takeup of wire or cable, plastic tubing in the case of strand material, as compared to the coating of textiles with plastic for electrical insulation or decorative coated fabrics or papers.

* * *

THE choice of specific equipment components such as types of winding units, precise speeds of operation and processing requirements shall not be considered as we wish to favor a broad viewpoint of the entire art of handling this type of material. The subject is the complete drive system taken as a whole and not in its several component parts. (Figure #1)

* * *

LET us define exactly what we mean by a web material. Web materials are flexible materials of relatively small thickness and usually great width, usually processed in continuous or long lengths. These materials are continuously wound on rolls or on beams. Examples of such types of material would be fabric or paper or plastic, when it is considered in roll or continuous form.

* * *

IN direct comparison to web materials, a strand material is any continuous or nearly continuous material of relatively small circular or similar uniform cross-section. This material is wound on reels or spools or in coils in relatively long lengths. Such materials obviously, are wire, cable, cord, yarn, rope or any similar material.

* * *

IN the correct observance of the term, the name monofilament specifically refers to the synthetic solid materials of small cross sections which materials are manufactured by either the spineret or the extrusion process. These materials are generally of a completely homogeneous cross-section whereas the strand materials, etc., such as wire, cable or other materials may not be.

* * *

HOWEVER, in this particular discussion, the terms are used synonymously except where noted.

* * *

DURING most phases of the original manufacture of either of these materials they are handled continuously. This will apply to either the original weaving operation, slashing, dyeing, or similar process in the case of textiles through to extraction, calendering and finishing in the case of paper. In the case of strand materials, wire is handled continuously in the drawing of the metallic conductor, in its braiding, its extrusion coating, its stranding or bunching, in fact in almost every phase of wire manufacturing operations.

* * *

IT is however, not our intention to treat here the basic manufacture of these items, but to dwell upon the problems involved in the handling of the material either in stages of their manufacture or in their conversion into their final form.

CONTINUOUS WEB MATERIALS
- PAPER – ALL TYPES
- TEXTILES – WOVEN, WEFTLESS
- FILMS – NYLON, ACETATES
- TAPES – WIDE WIDTHS

CONTINUOUS STRAND MATERIALS
- WIRE – ALL TYPES
- MONOFILAMENTS – NYLON, RAYON, GLASS
- CORDS – ELECTRIC, TEXTILE
- TAPES – NARROW
- TUBINGS – PLASTIC, RUBBER

Figure 1. * * * * *

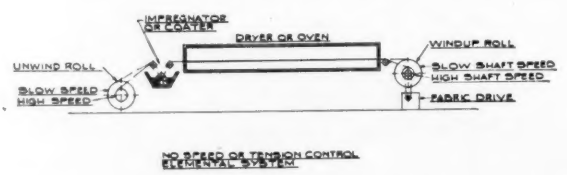


Figure 2. * * * * *

MANY finishing operations similar to the coating of textiles with plastics to make artificial leathers, the insulation jacketing of electrical cables or wire, or the extrusion forming of plastic tubing all have common handling problems.

* * *

MOST of these can be variously solved by any one of the seven basic methods herein described.

* * *

IN case of bulk material handling or conveyorized handling of a specific object well known and long used principles are employed. In the handling of continuous web or strand materials lesser known principles are used and because the field is of more recent origin they are as yet not generally understood.

* * *

IN order to simplify the subject, a typical handling problem is elementally pictured in the illustrations shown. The illustrations and text organize the same basic elements in terms of several methods of applying several types of system drives to the operation. The general advantages and limitations of each will be listed for general comparative purposes.

* * *

IT is necessary to bear in mind that in a short treatment of such a broad field, it would serve no purpose to describe these systems in terms of precise mechanical, electrical or hydraulic equipment components. Rather it is the purpose here merely to describe these drives in their functional elements.

* * *

FIRST, we will describe the handling of textiles, paper or film through a simple coating and drying operation.

* * *

AFTER completion of the portion on web materials the strand materials will be discussed from the same functioning drive viewpoint.

* * *

IN continuous flexible material handling the fundamental operation can be very elementally considered an operation in which one roll of continuous material is being rewound to another roll. This is a simple rewinding operation with a coating and drying operation in between these two rolls.

* * *

BECAUSE this operation is fundamental it will be referred to from its simple form to a more complex variety to follow.

* * *

IN this operation, as well as in any other operation discussed, there is one major controlling consideration. That consideration is speed control.

* * *

HERE, as Figure #2 indicates, is a constant rotational speed on the windup roll shaft with the unwinding fabric coming from roll "A" and the fabric being rewound on roll "B". Roll "B" provides the pull for propelling the fabric.

* * *

WITH a constant shaft speed on the propelling roll, the speed at which the material travels between rolls increases in direct proportion to the diameter buildup of the windup roll or the fabric speed accelerates uniformly in proportion to the increase in the roll diameter. On the unwinding roll the opposite function, that is roll shaft acceleration, simultaneously occurs. Accordingly, with constant speed on shaft "A", the speed of the fabric varies in proportion to the increasing diameter while on shaft "B" the shaft speed is increased in direct proportion to the diameter decrease, and the diameter increase of roll "A". Obviously in a system like this there are three simultaneous variable elements. They are as follows:

with a constant windup shaft speed

1. **Uniformly accelerated fabric speed due to windup roll diameter increase.**
2. **Accelerating rotational speed of the unwinding shaft due to windup roll diameter decrease.**
3. **Improper and uncontrolled tension values in the material.**

* * *

OF these variables the first is the most important because of the definite speed relationship in the impregnation and the drying operation. As the speed of the material varies the drying and impregnation rates are obviously changed. As a matter of fact, the only reason for handling any material is the processing of the material that occurs between the unwinding and winding operation. In most operations processing times are of critical importance and therefore constant material speed is mandatory. Accordingly, the speeds of the unwinding or winding roll or shafts is secondary in importance as long as they do not functionally impair the constant speed of the material, or because of lack of synchronization, alter the tension values.

* * *

SINCE speed or material velocity is the most important element, let us accordingly introduce a positive driving element to provide constant speed on the actual material being processed. This is being done in the form of pull rolls, whose function is to propel the fabric at a constant velocity. By so doing we have removed the most detrimental of these handling variables, leaving the more easily controlled accelerating and decelerating shaft speeds yet to be controlled.

(*Please turn to page* 1064)

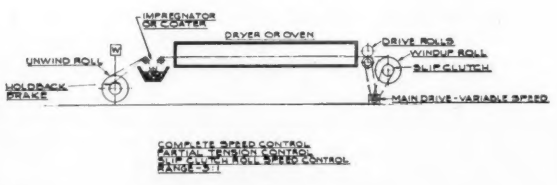


Figure 3.

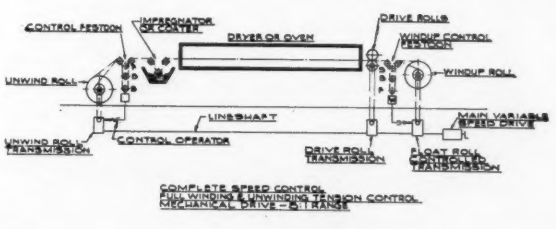


Figure 4.

INDUSTRIAL DIAMOND ASSOCIATION
OF AMERICA, INC.

STEPHEN W. HOFFMAN, President CHARLES J.KOEBEL, 1st. Vice-President WALTER J. MEINHARDT, 2nd Vice-President

Communications:
ATHOS D. LEVERIDGE
EXECUTIVE MANAGER
& Secretary-Treasurer
501 LEXINGTON AVENUE
NEW YORK 17, N. Y.
WICKERSHAM 2-1400

For Good Productivity In Diamond Dies

Open Letter to the Wire Manufacturing Companies

By Athos D. Leveridge, Executive Manager

The third of a series of letters directed to The Wire Drawing Industry.

IN the two open letters which preceded this communication in the series published through the courtesy of "Wire and Wire Products", the **Industrial Diamond Association** stressed its fear of deterioration in the quality of diamond dies to be produced in future and gave reasons. Also, there was expressed a need for realistic cooperation from the wire manufacturers.

* * *

IN accordance with the postscript to the Association's Letter No. 2, October issue, we would now like to indicate means by which the wire manufacturer may cooperate with the die producer. This, in the interests of, first, the production of the best possible wire in the most economical manner, secondly, maintenance of a healthy diamond die producing industry wherein the highest grade will be universally produced.

* * *

OUR suggestion previously made, that wire records of the life of all dies through each successive recut be kept and the poundage for the total life of the dies tabulated, has already had a positive response from wire producers. As it indicates that most progressive wire men do consider that only by knowing the reasonable average yield of their diamond dies in various sizes, can they be in a position to know what value to expect of the dies, little more need be said on the subject. Where such records are not already kept, a competent accountant, working with the die room engineer, will be able to lay out a simple system for the purpose.

A standard "Operator's Drawing Record" card has been proposed by some authorities and is under consideration.

* * *

WE come to what is believed the greatest step forward ever undertaken to safeguard quality, hence productivity with economy, in American-made diamond dies. It is a step never taken by the continental diemakers of Europe. At the request of the diamond die producers of the Industrial Diamond Association, both East and West, the I.D.A. took steps which resulted in a meeting at this office with the head of the Standards Division of the National Bureau of Standards. There was proposed the establishment of specifications on original diamond weights, net weights, general quality and inspection methods for diamond dies, and tentative schedules were submitted for consideration.

* * *

THE formalities related to formulating Standards Specifications which will meet industry requirements, properly safeguarding industry and the quality of a product, but at the same time permit the flexibility required in order not to interfere with commerce, will necessitate many meetings and other work. There is every expectation, nevertheless, that the Industrial Diamond Association will succeed in obtaining a relatively prompt promulgation of diamond die standards to cover the premises, providing the proper cooperation is received. This cooperation is promised by government and by all of the diamond die producers in the Association. These producers account for the majority of the diamond dies produced in America.

* * *

WHILE our letter could not properly present more details at this time, it can be stated that what appears now to be required is the full and hearty cooperation by the wire manufacturers in this excellent, forward-looking project in the mutual interest.

* * *

THE cooperation asked of the wire manufacturers is that: (1) They demand quality first and foremost when acquiring diamond dies; (2) They join in sponsoring the promulgation of the Standard Specifications by the Government; (3) Once Standards are made official, their purchasing departments insist upon diamond dies that conform to the Standards; (4) They cooperate with the diamond die industry in establishing Standard inspection methods for use when dies are purchased, with the specifications for magnification and illumination to be published along with the die Standards. The latter will be based upon the practical power of magnification applicable to each size of die, and neither too weak nor too strong to properly make clear to the examiner the workmanship and quality of the die. That is, within the very definite limits which any die inspection will permit. The power and type of illumination will be prescribed and will be governed by the given power of the loupe and the size of die.

THE I.D.A. appreciates the cooperative attitude of the Wire Association in helping us to assist both the diamond die industry and the wire manufacturers. We appreciate the attention which is being evidenced by the wire manufacturers in our series of Letters, as evidenced by communications from wire manufacturers. These will be taken up by a Committee of the diamond die producers.

* * *

WE also respectfully request that the wire manufacturing company officials and their engineers read the fourth, and possibly the last of the current series of Open Letters written by the I.D.A. to the wire manufacturers.

* * *

Foreign Notes

THE plan established by the United States allowing Germany a total production of 10.7 million tons of steel annually has been found impossible to execute.

* * *

THE controlling commission, consisting of 7 United States business men touring Western Germany at present with the view of ascertaining productive capacity, has found that due to the dismantling of existing works and other damages the production planned of 800,000 tons of hot and cold rolled hoops must be reduced by 40%; that of joists, beams and other structural steel of 3,410,000 tons by 21%; of heavy and medium plates of 3 mm and thicker, 830,000 tons must be reduced by 47%; the estimate of 900,000 tons of thin sheets must be reduced by 22.3%; and that the estimate of 880,000 tons of wire and wire products must be reduced by 35.6%. The estimate of 560,000 tons of tubes must be reduced by 25.7%, and of others by an average of 38%.

* * *

THESE figures are based on productive capacity of September 1948. However, on September 26th the dismantling of Europe's largest and most modern steel works — the August Thuyssen Hütte began — and with the completion of this dismantling, the figures above will be reduced by another 30 to 40%, and wire production will suffer a further reduction of 164,000 tons.

IN this connection it is interesting to know that the dismantling of the plants in the Ruhr will be executed with D. P.'s (displaced persons), chiefly Ukranians and Polish, under protection of the British Military Police and armored cars, as the local workmen refuse to do the work.

* * *

THE final finding of the American commission has not yet been made known, but it is probable that the industrial plan established by the United States for Western Germany cannot be executed.

* * *

THE United States is spending at the moment approximately $800,000,000 annually for the feeding of the German population. The cost of rebuilding the Western German heavy industry would require a capital investment of $1,100,000,000, none of which can be raised in Germany.

* * *

FURTHER, since all the machinery and equipment plants needed to build machines and provide equip-

TRADE MARK REG. U. S. PAT. OFF. MICRO WELD MICROMETER PRECISION

MODEL M-T, FOR BENCH MOUNTING

This welder was designed and developed expressly for welding all types of fine wire: Aluminum, Copper, Brass, Bronze, Steel and Steel Alloys, ranging in size from .005" to .020" diameter.

Unit design of frame, transformer and power sub-assemblies permit other range of sizes to suit requirements.

Equipped with a temperature indicating annealing and tempering device, voltage regulator and meter to compensate for voltage fluctuation, wire cutters, extra large 5" diameter magnifying glass, fluorescent light and extension cord. Welder can be supplied for bench mounting, or mounted on 4-wheel truck.

The adaptability of this unit for welding all types of wire, either ferrous or non-ferrous, in sizes from .005" to .020" diameter, makes it ideal for the fine wire manufacturer.

MICRO PRODUCTS COMPANY
20 NORTH WACKER DRIVE
CHICAGO 6, ILL.
Telephone: State 2-7468

Keystone's new Galvanized MB Wire offers improved corrosion resistance. It gives added life and strength to mechanical springs subject to rust and corrosion. This is due to Keystone's unique method of galvanizing the wire **before** it is cold-drawn. The drawing process smooths and hardens the galvanized finish, increasing its lasting qualities remarkably. Other advantages are its lustre-bright, shiny smooth finish . . . even, uniform temper . . . and high tensile strength.

Whatever your industrial wire problem might be, Keystone's wire specialists can help solve them for you. You are welcome to call on them at any time.

KEYSTONE STEEL & WIRE COMPANY
PEORIA 7, ILLINOIS

ment for the rebuilding of the German steel industry have also been destroyed or damaged, Germany cannot produce at present a single machine to make barbed wire, wire rope, or wire netting. On the export market, the demand has revived for almost all wire products. The Belgium-Luxembourg wire industry has booked orders from the Far East, the Near East (including Israel), and now the Latin American market is placing orders after a stop of some months.

* * *

ARGENTINA is bartering agricultural products for Belgian barbed wire, fencing wire and so forth. Uruguay and Chile are doing the same thing. Prices are unaltered by the exchange arrangement.

* * *

INDIA has placed important orders for wire nails, and Pakistan has bought annealed wire and wire netting. The outlook for the continuation of export orders seems promising.

* * *

CZECHOSLOVAKIA has placed important orders for wire machinery in England and so has Russia, the latter for L641,000 with Craven Bros. and other companies. Czechoslovakia has bought wire drawing machinery principally.

* * *

RUSSIA has bought 1,800 tons of wire rope of high quality in Belgium and 360 tons of cable in Switzerland, and also 1,700 tons of high tension transmission wire.

* * *

SPAIN has placed more orders for Swedish wire rods on an exchange basis. The Spanish government permits imports of German products on an exchange basis, but the J. E. I. A. in Germany has not yet authorized such transactions.

* * *

THE complete stoppage of imports in Portugal continues, and will not be lifted before the end of this year. Most orders for American products, including wire netting, wire screen, etc., had to be cancelled due to the shortage of American dollars.

Outstanding Personalities of the Wire Industry

Arthur A. Nelson

ARTHUR A. Nelson, former Asst. General Sales Manager of the **Keystone Steel & Wire Company**, died at Wausau, Wisconsin, on October 4th. Mr. Nelson had retired June 30, 1947, after 41 years of continuous Keystone employment.

* * *

ART Nelson had joined Keystone on March 9, 1906, his 21st birthday. During the first four years, he had worked as stock room clerk, order recorder, traffic router, and correspondent. In 1910, he had been promoted to field salesman, the firm's first representative in Missouri, Kansas, and Oklahoma. Advanced to sales director in 1915, he had spent the following 20 years supervising various divisions of the sales department. His appointment as assistant general sales manager took place in 1935.

* * *

Frank Patnaude Joins H. J. Ruesch Machine Company

FRANK Patnaude has recently been appointed New England representative of the **H. J. Ruesch Machine Company** with offices at 159 Croom Street, Providence, 9, Rhode Island.

* * *

MR. Patnaude was formerly superintendent and for the last twenty years sales manager of the Standard Machinery Company of Providence, R. I.

* * *

Shea Now Heading Teletype

TIMOTHY E. SHEA, assistant engineer of manufacture of the **Western Electric Company**, has been elected president and a director of the Teletype Corporation, effective October 1, it was recently announced. He succeeds the late Clem H. Franks as head of Teletype, a subsidiary of Western Electric engaged in the manufacture of printing telegraph equipment used in the teletypewriter and private wire services of the Bell System and other companies. Mr. Shea brings to his new assignment 28 years of varied experience in Western Electric's engineering department and in Bell Telephone Laboratories.

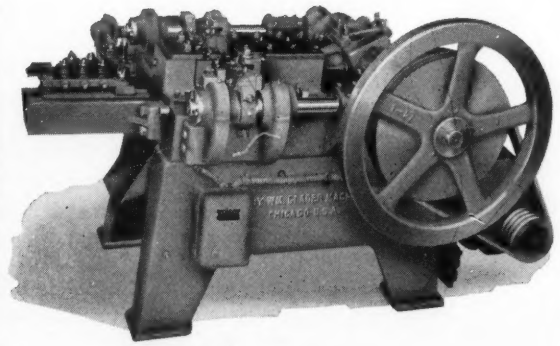
* * *

Eaton Manufacturing Company Appointment

M. P. Winther has been appointed vice-president and director of engineering. **Eaton Mfg. Co.**, Cleveland. Mr. Winther has been associated with Eaton since 1946 when the company acquired the Dynamatic Corp. of Kenosha, Wis., of which he is president. He also serves as a director of the Eaton Co.

* * *

GLADER HIGH SPEED WIRE NAIL MACHINE



MACHINE ARRANGED FOR INDIVIDUAL MOTOR DRIVE

High tonnage output, and low maintenance costs, have resulted in Glader Machines being accepted as standard equipment in every large nail mill built in the United States in the past twenty years.

Glader Machines are operating in most of the wire producing mills throughout the world.

These machines are made in eleven different types and sizes. This enables us to cover the range of sizes of nails produced with the greatest efficiency.

For further information please address,

WM. GLADER MACHINE WORKS

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Chicago 7, Illinois

Export Dept.: 122 E. 42nd Street, New York 17, N. Y.

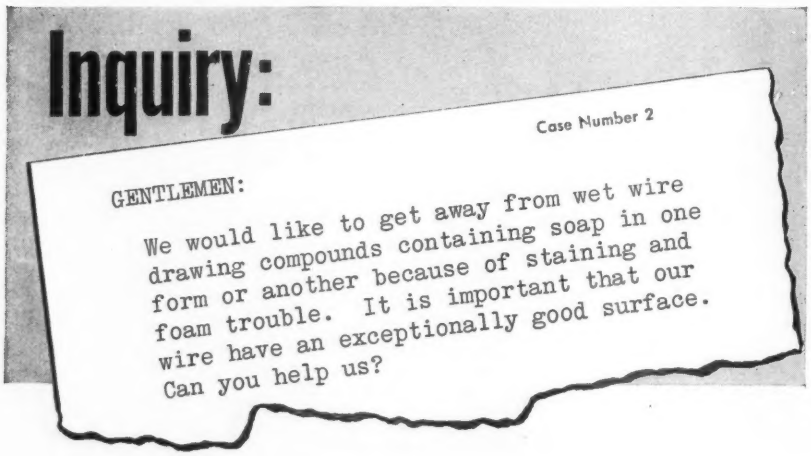
Dickenson Now Heads Townsend Company

H. C. Weidner has retired as president of the **Townsend Co.**, New Brighton, Pa., and has been elected chairman of the board of directors. **Frederick R. Dickenson** has been elected president and **Joseph S. Thompson** has been appointed general sales manager. Mr. Weidner joined the company in 1913 and has been president since 1928. Mr. Dickenson joined the company in 1947 as executive vice-president. Mr. Thompson joined the company earlier this year as assistant to the executive vice-president.

* * *

Keystone Steel & Wire Company Elects

KEYSTONE Steel & Wire Co., Peoria, Ill., announces election of **E. J. Sommer** as director for a three-year term to succeed **R. J. Kavanagh**, whose term expired. **D. P. Sommer** and **Theodore C. Baer** were re-elected for three-year periods.


Inquiry:
Case Number 2
GENTLEMEN:
We would like to get away from wet wire drawing compounds containing soap in one form or another because of staining and foam trouble. It is important that our wire have an exceptionally good surface. Can you help us?

Answer: Our answer to this and similar inquiries is the extensive research program now being conducted by NOPCO* LABORATORIES to effect improvements in NOPCO'S Wire Drawing Compounds.

These improvements include (1) changing the structure of the fats and oils in these compounds, thus enabling them to create a *stronger* bond between metal and lubricants . . . and (2) the production of more *stable* fatty compounds.

NOW IN PRODUCTION. These special research projects *supplement* rather than *supplant* NOPCO'S regular activities in the production of metal working products. NOPCO Wire Drawing Compounds are available now.

Wire Manufacturers: Perhaps we can answer your wire drawing problem. Write us.

*Reg. U.S. Pat. Off.

NOPCO CHEMICAL COMPANY, Harrison, N.J.
FORMERLY NATIONAL OIL PRODUCTS COMPANY
Branches: BOSTON • CHICAGO • CEDARTOWN, GA. • RICHMOND, CAL.
NOPCO EVOLVED THRU RESEARCH

Shilling Retires at Youngstown S. & T.

J. Harvey Shilling has retired after 31 years with **Youngstown Sheet & Tube Company**, 14 years as superintendent of the company's rod and wire plant at Struthers, O. Mr. Shilling, a native of San Francisco, joined Youngstown Sheet & Tube Company in 1917 as secretary to W. C. Reilly, general superintendent. He was made assistant superintendent of the rod and wire plant in 1920 and became superintendent 14 years later. He is a member of the Wire Association.

* * *

Vascoloy-Ramet Corporation Opens New Warehouse

VASCOLOY-RAMET Corporation, North Chicago, Ill., has opened a warehouse and distribution offices in Birmingham at 308 North 26th Street. The plant here will serve the Southeast territory and will export to Cuba and parts of South America.

* * *

E. I. Du Pont Appoints

ROSS Hare has been named manager of the electrochemicals department of E. I. du Pont de Nemours & Co., Inc., plant in Wilmington, succeeding Dr. Newton C. Jones, who died recently.

* * *

Keystone Host to Mid-States Foremen

WIRE Mill foremen of the **Keystone Steel & Wire Company** were hosts October 1st and 2nd to the wire mill foremen of the **Mid-States Steel & Wire Company**, Crawfordsville, Indiana, subsidiary of Keystone.

* * *

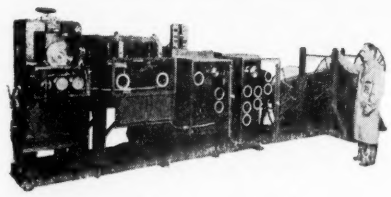
AT this sixth annual get-together, a dinner was given, at which **John A. Moritz**, Keystone's Wire Mill Superintendent, was master of ceremonies, concluding activities.

* * *

PLANS at Peoria were developed by a committee consisting of John L. Sanderson, Chairman, Henry G. Cordes, J. G. Weiss, A. H. DeYoung, and Oran Bryne.

New Cable Stripper Built by Black

A new cable-stripping machine is announced by **Black Industries**, 1400 E. 222nd. St., Cleveland, Ohio, for the speedy reclaiming of cable with imperfect insulation.



Black's New Cable Stripper. * * * *

THE cable enters the machine at left over the rollers and under the circular knife which slits the layers of insulating materials. Depth of slit may be adjusted to avoid cutting of the interior cable. Machine is so designed that as many as three different insulating materials may be stripped from the cable, separated from each other by the series of serrated rolls, and taken up on individual reels, the cable itself being taken up separately.

* * *

THIS machine is simple to adjust and operate and requires a minimum of attention.

* * *

ABOUT 1500 feet of electrical wire is used in an average size house. Such wire is being produced at the rate of 6,000,000,000 feet a year, which is three times the pre-war record, to keep pace with home and commercial construction.

Wear Resistance of Wire for Wire Rope

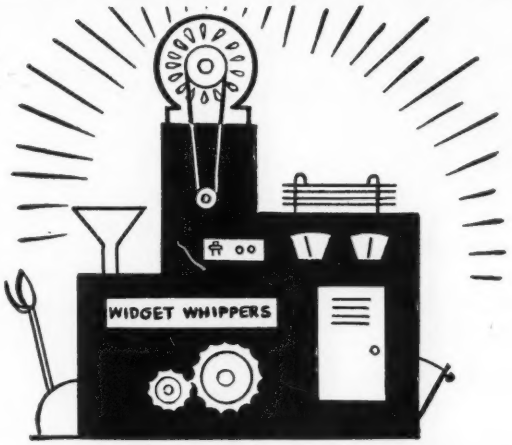
(*Continued from page* 1047)

produced by friction. Later **Trent** (3), in a masterly research, showed beyond all doubt that these films were caused by frictional heat followed by chilling from the body of the wire. Fig. 26 shows a typical film from a worn haulage rope which is of a composite character, one film having been superimposed on another which has caused some tempering of the film first formed. Some doubts have been expressed by competent authorities as to the temperature at which this film is formed as it has been difficult to visualize how a temperature in excess of the critical transformation point can be induced by frictional contact on slowly moving ropes without some obvious evidence of its formation. Trent has shown that it is impossible to produce Martensite by striking the wire surface with hard steel tools and it is probable that the severe pressure and heavy flow occurring in service has some influence on the position of the critical temperature point.

* * *

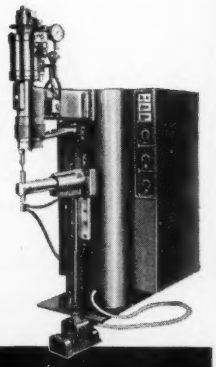
IT is necessary to draw a clear distinction between this type of brittle surface film and the more common cold worked film; the term "work hardened" sometimes applied

Whether you make Whippers



. . . or pots and pans, or trucks, or stoves, or any product fabricated of metal . . . you'll be interested in the story of Mr. Widget. He was faced with the dilemma of wanting to use resistance welding but not having sufficient plant transformer and distribution facilities to handle the extra load. Also the power people frowned on the addition of a *low power factor* load.

How Mr. Widget became a "Man of Success" with the aid of "THREE PHASE" is briefly told in the booklet; "How Mr. Widget Made More Whippers." Your copy is waiting—just drop us a post card. You'll find it well worth the 3 minutes reading time (not counting technical stuff.)



Manufacturers of a complete line of resistance welders. Offices in New York, Detroit and Dayton. Representatives in Principal Cities

SCIAKY

SCIAKY BROS. Inc., 4923 WEST 67th STREET, CHICAGO 38, ILL.

to these Martensite films is, perhaps, unfortunate as the condition is clearly due to a temperature transformation effect.

Summary

A reliable method for determining the surface flow characteristics of Patent Steel Wires has been developed, from which results have been obtained indicating great differences in the behaviour of wires produced by different methods of manufacture.

* * *

ARISING out out of this research, the following points are of particular importance:

1. **The method of patenting has a marked effect in determining the resistance of wires to plastic wear.**
2. **The resistance to plastic flow is directly related to the tensile strength of the wire.**
3. **The composition of the steel is more important than the amount of cold work given in wire drawing.**
4. **Plastic wear in wire ropes is found to consist of the production of a severely cold worked film which may be exceedingly brittle, depending upon the nature of the wire manufacturing process. This surface layer is continuously removed and replaced under the action of a wearing influence and the process, therefore, is one of attrition taking place in a severely embrittled film.**
5. **The so-called "work hardened" films differ substantially from those mentioned in this report. They consist of hard, brittle, Martensite produced by frictional heat. Where they occur they cause rapid destruction of the rope.**
6. **A careful selection of the wire manufacturing process in relation to the conditions of usage of wire ropes is desirable if the maximum service is to be obtained from them.**

References

1. **"Drawing of Steel Wire and its Relation to Qualities of Steel." Journal of the Iron and Steel Institute No. 1. 1927.**
2. **Mitteilungen Kaiser - Wilhelm - Institut. Volume XVI/21. No. 246. P. 15-19.**
3. **"Formation and Properties of Martensite on the Surface of Rope Wire." Journal of the Iron and Steel Institute, 1941.**

Thanks are due to the Chairman and Director of Messrs. Rylands Brothers, Limited and the Whitecross Company, Limited, Warrington, for permission to publish this report. The writer is indebted to Lt. Com. G. K. Rylands for his constant interest and help and to Mr. Bernard Ryan for carrying out the work in an exemplary manner.

* * *

Furnace Engineers Buy Pittsburgh Building

FURNACE Engineers, Inc., have purchased the office building located at 1551 West Liberty Avenue, Pittsburgh, according to Harry Dobrin, firm president. Engineering and general offices of the corporation have been located in the building since the firm was founded in 1943. The purchase price was not disclosed.

* * *

FURNACE Engineers design, construct and install heat treating furnaces for the steel industry.

YOUR COMPLETE CARBIDE
REQUIREMENTS
FROM **ONE** SOURCE

DIES

Large stock of rough cored dies. Rough and Semi-finished mandrel nibs, Heading & Extrusion dies, Knives and Quills, Wear Parts and miscellaneous Carbide items can be furnished promptly to your specifications.

TOOLS

Large representative stock of WENDT-SONIS carbide cutting tools including single point tools, Reamers, Drills, Counterbores etc.

Quotations Furnished on Request

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Representatives of Hyprez Diamond Lapping Compounds for Your Die Room Needs.

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COMPLETE CARBIDE SALES & SERVICE

A Review of Recent Wire Patents

No. 2,448,633, INSULATED ELECTRICAL CONDUCTOR, patented September 7, 1948 by Charles C. Smith, Cranford, N. J., assignor to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York.

About the wire is a single end of cellulose acetate rayon yarn spirally wound with overlapping edges on the wire and formed of a number of continuous filaments held in a uniformly complete group free to spread into a uniform cover with interlocking filaments at the overlapping edges by a low twist in the yarn from .3 to .75 turn per inch.

★ ★ ★

No. 2,448,941, METHOD FOR FABRICATING WELDED WIRE FABRIC, patented September 7, 1948 by Theodore Harry Wickwire, Jr., Ardmore, Pa., assignor to Theodore H. Wickwire, Jr., Sophie H. Wickwire, Roma A. Wickwire, and Hedge Wickwire, co-partners doing business as Theowick Company, Philadelphia, Pa.

The method includes continuously and simultaneously moving a number of wire strands, successively placing transverse wires across the strands, and electrically welding the transverse wires in succession by successively welding each transverse wire to each of the different wire strands.

★ ★ ★

No. 2,449,045, EXPANSIBLE FISHHOOK, patented September 14, 1948 by Francis P. Athans, Fort Worth, Tex.

This fishhook comprises a pair of wire shanks having hooks at corresponding ends thereof and including a spring therebetween for normally diverging the same, and a lateral bend in one of these shanks for engaging the other of the shanks when the hooks are in their expanded position, and a smaller lateral bend on the first named bend for detachably engaging the other of the shanks.

★ ★ ★

No. 2,449,500, CHAIR SEAT, patented September 14, 1948 by Walter E. Nordmark, Grand Rapids, Mich., assignor to American Seating Company, Grand Rapids, Mich., a corporation of New Jersey.

Upwardly arched sinuous wire springs span the seat frame from side to side and are secured thereto, while the ends of a resilient wire are secured to the frame sides, and the intermediate portion of the wire extends forwardly and upwardly beyond the foremost spring.

★ ★ ★

No. 2,449,507, STRETCHING MACHINE FOR UNCOILING, FLATTENING, AND COILING METAL STRIP, patented September 14, 1948 by Alfred Pope, Penn Fields, Wolverhampton, England, assignor to Joshua Bigwood & Son Limited, Wolverhampton, England, a British company.

Uncoiling devices are disposed on a table, slidable along a guideway of a two-part frame portion.

No. 2,449,653, FILAMENT FORMING APPARATUS, patented September 21, 1948 by Elmer B. Isaac, deceased, late of University Heights, Ohio, by Dorothy J. Isaac, administratrix, University Heights, and Francis J. Rippl, Cleveland, Ohio, assignors to General Electric Company, a corporation of New York.

There are 17 claims for apparatus for shaping wire coil into lamp filaments, which apparatus includes an anvil and two fingers to receive therebetween a turn of wire coil with the anvil projecting into the wire coil from one side thereof and within the pitch space of the coil turn and with the fingers projecting into the coil from the opposite side thereof and within the pitch spaces at either side of the coil turn.

★ ★ ★

No. 2,449,726, DIRECT COATING OF SILVER ON IRON OR STEEL, patented September 21, 1948 by Alfred Daniel Slatkin, Toronto, Ontario, Canada, assignor to Arthur F. Cutten.

The method comprises placing a ferrous metal cathode in an aqueous bath having sodium cyanide 8 to 15 ounces, silver cyanide ¼ to 2 ounces, sodium chloride ¼ to 2 ounces, potassium carbonate ⅛ to 1 ounce, to a gallon of water; placing an iron anode in this bath and passing

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an electrical current of a value between 30 to 200 amperes per square foot of surface area of the cathode, between the anode and cathode.

* * *

No. 2,449,834, WIRE COVERING MACHINE, METHOD, AND PRODUCT, patented September 21, 1948 by Charles W. Bechle and John W. Olson, Sycamore, Ill., assignors to Anaconda Wire and Cable Company, a corporation of Delaware.

A forming head is provided to form a tube of paper provided concentrically about and spaced radially from a wire into a plurality of loops disposed radially about the axis of the wire.

* * *

No. 2,449,865, MACHINE FOR FORMING AND APPLYING CLIPS TO WIRE MEMBERS, patented September 21, 1948 by Edgar Tanguay, Bloomfield, N. J., and Carl Kertesz, Jamaica, and Wallace Krakauer, Rockaway Park, N. Y., assignors to Samuel Krakauer, Rockaway Park, N.Y.

This is described as an improvement upon the invention disclosed in U. S. Patent No. 2,329,202 of September 14, 1943 and is a machine for securing together coil wire springs for spring mattresses and the like.

* * *

No. 2,450,007, CARBURIZED FILAMENT AND METHOD FOR TREATING THE SAME, patented September 28, 1948 by Charles V. Litton, Redwood City, Calif., assignor to Federal Telephone and Radio Corporation, Newark, N. J., a corporation of Delaware.

A wire is provided for mounting in an electronic discharge device and consists of a tungsten-containing core surrounded by an outer layer of thoriated tungsten carbide having a crazed surface and no connection other than surface contact connection with the core.

* * *

No. 2,450,077, WIRE-DRAWING DIE LAPPING MACHINE, patented September 28, 1948 by Paul Bieberich, Fort Wayne, Indiana.

The assembly consists of a series of arms pivoted for lateral swinging, a rotary arbor provided with a die mount and a pulley, a spindle mounted in bearings on one of the arms, having axial reciprocating and rotary movement and provided with another pulley, brackets pivotally mounted on the other arms, a cam shaft extending through the brackets having a cam between the brackets, a rock shaft extending through the brackets provided with a grooved collar, an actuating arm on one of these brackets engaging the collar to activate the rock shaft axially, a finger loosely mounted on the rock shaft connected with the spindle to reciprocate it through the medium of the cam, a sliding bar having reciprocating movement in guides on the frame and provided with adjustable dogs that engage in splines in certain of the arms respectively, a mechanism for activating the sliding bar, and motion transmitting device to rotate the cam shaft, the arbor and the spindle.

* * *

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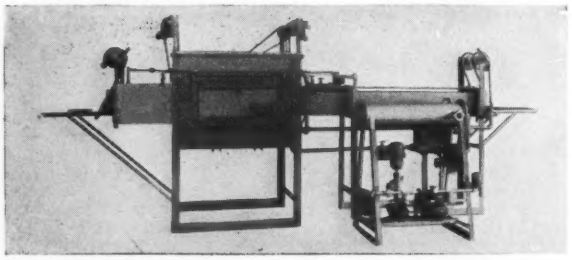

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The Handling of Webs and Monofilament Materials

(*Continued from page* 1055)

BY imparting constant velocity to the material by positive driving means the most important element of the process, namely, variable material speeds, has been solved.

* * *

TURNING again to our elemental material handling problem the addition of drive rolls makes the system look as shown in Figure #3.

* * *

ESSENTIALLY, all of the elements of this system are still the same, with these distinct differences:

1. **The pull rolls and their drive propel the material at uniform velocity.**
2. **The unwinding rolls are equipped with a friction brake to impose tension on the material.**
3. **The windup roll shaft is driven by the main fabric drive through a slip clutch.**

* * *

WE have added a drive in the form of main pull rolls to drive the material and at the same time, rotate the windup roll through a slip friction clutch. The slip clutch is employed to provide a variable torque or pull on the roll shaft and

to provide a mechanically variable element to compensate for the speed decrease as the diameter of the windup roll increases.

* * *

THE letoff reel shaft is friction brake equipped to add braking effect to the roll. This imposes hold back tension on the material. By so doing, we have prevented overriding of the fabric during deceleration and have partially added limited hold back horsepower on the material.

* * *

THIS is the second step in the evolution of a continuous material handling system and in it we have some elemental degree of processing control over the entire operation.

* * *

IN an attempt to control the speed synchronizing of the system, we have rendered the speed constant and by the imposition of the hold back braking tension on the unwind roll we have now introduced some element of tension control into the system.

LIKEWISE, by controlling the tension through the slip clutch on the windup roll shaft we have provided a limited range of tension control on the windup material.

* * *

THIS commonly used system seldom operates satisfactorily over long periods of time even over narrow speed ranges and with materials of very high tensile or tensile strength. Judged by today's engineering standards it is quite elemental.

* * *

TENSION, as it applies to a system of this nature, is the amount of longitudinal pull on the material between any given two points in the system. More correctly, it is longitudinal stress in the material induced by tension rolls or speed synchronization, or by lack of synchronization as the case may be.

* * *

IN any continuous material handling system the control of tension is important and second only to speed control. Variations in tension effect coating depositions, drying rates, fabric width and tightness of the material as it is wound on the final windup roll. All of these factors must be controlled within accurate limits for most processing operations.

* * *

BECAUSE of the importance of close tension control in fabric coating, materials with low tensile or strength are inadequately processed in a system of this type. Available clutch facing materials operate within a very narrow speed range and they do not deliver satisfactorily constant horsepower output with variable speed ratings. Systems of this type require constant and careful manual adjustment and maintenance.

* * *

Mechanical System Drive

IN consideration of both speed and tension control within precise and predictable limits, the handling system shown must be improved to provide for both speed and tension.

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FIGURE #4 indicates the elemental system with the same components plus a driven unwind stand and two new units called float rolls. One is placed at the letoff roll and one at the windup roll. These very useful units are control loops, which essentially are a group of two upper fixed idler rolls and one idler roll free to travel (in suitable guides) in a vertical plane. The traveling roll is supported in a loose loop in the fabric. By changing the loop length the position of this free idler roll varies.

* * *

THE fundamental purpose of these float roll units is to measure continuously the speed of the fabric and correct the driving speed of the rolls through mechanical, hydraulic or electrical methods depending upon the main system drive.

* * *

BASICALLY the principle of the float sheave is one of the continuous measurements of the speed difference in the material entering the loop and leaving it. Obviously, if less material enters the loop than leaves it, the difference causes the float roll to raise or lower. Suitable mechanical linkages integrate the position of the roll in terms of roll drive speeds, thereby continuously increasing the speed of the unwind roll shaft as its diameter decreases. At the windup roll the float sheave decreases the windup roll speeds in direct proportion to the increasing windup roll diameter.

* * *

SPEED integration is the primary function of this control loop, but it has a coincidental and very important secondary function. That function is tension control.

* * *

TENSION as previously mentioned is longitudinal stress or load on the material between given points in the system. Thus, by controlling the weight of the float roll or by adding mass or pneumatic loading as requirement demands, it is practical to add tension to the material without affecting the material speed. Counterweights are added to the vertical roll frame in proportion to the number of individual passes to the loop and the amount of net tension desired in the material. In the case of one loop as shown, the roll weight is uniformly distributed on both legs of the loop so that the amount of tension on the material is obviously ½ of the roll weight.

* * *

IN cases of higher tensions, counterweights may be added to the roll. In this case the counterweight mass sometimes becomes a space and designing problem. In such a case pneumatic or hydraulic loading with compound linkages are used to impose force on the traveling roll, which in turn transmits that force to the fabric in terms of tension.

* * *

IN cases of extremely low tensions, the roll is made of light materials or its masses mechanically counterbalanced.

* * *

LET us, however, examine the entire system drive to see the complete new mechanism layout. This typically simple layout utilizes me-

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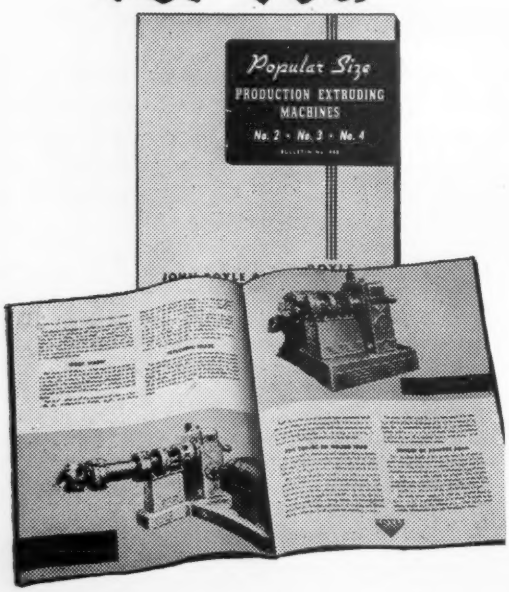

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chanical transmission for over-all system speed and float roll controlled variable speed mechanical transmissions for driving the unwind and the windup roll.

* * *

THE main drive of the system is a simple variable speed AC motor and mechanical transmission that in turn drives a line shaft which is positioned along the entire length of the system. By suitable power take-off, the lineshaft drives the fabric pull rolls which propel the material. Also simultaneously, the lineshaft synchronously drives the additional variable speed transmissions which in turn drive the unwinding and windup roll. The input shafts of these transmissions are driven at synchronous speed and the control of the output shaft speeds is continuously adjusted by the float roll unit, which through mechanical linkage, either slows down or speeds up the individual roll drive as indicated by the float roll position.

* * *

THUS, a relatively simple mechanical drive can be employed to provide accurate speed and tension control.

* * *

THERE are various drive units available which perform this variable speed driving function very efficiently. Some are simple lever-controlled transmissions and others are a very sensitive Servo Hydraulic valve and piston controlled unit giving a very fine degree of balanced sensitivity. Of the mechanical transmissions available for this operation, the Servo hydraulically controlled mechanical transmission is by far the most suitable for uniform tension control.

* * *

IN a system of this type detailed calculations of torques and horse-

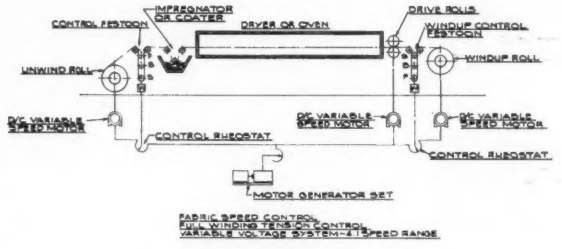

Figure 5.

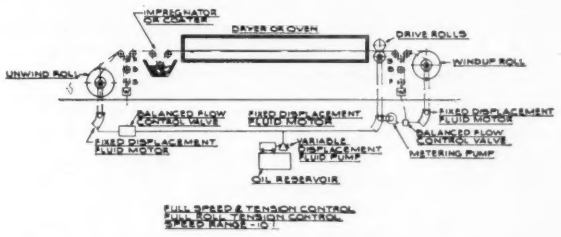

Figure 6.

* * * * * * * * * *

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powers are not required. Given the maximum tension desired in material and the maximum diameter of the rolls the drives can be sized on the basis of constant horsepower and variable speeds. The only requirement then is one of supplying units of maximum horsepower capacities to rotate the rolls against the floating-roll loading of the material, plus allowances for drive and friction losses.

* * *

A system of this nature is simple, accurate and relatively inexpensive. In mechanical operation, the speed of the main lineshaft directly varies the input speeds of the separate variable speed transmissions, simultaneously. In turn, float-roll control adjusts the output speeds appropriate for the roll diameter at the given instant. The speed of the pull rolls is constant for each given lineshaft speed. Accordingly, by one main adjustment all the rotational functions are completely controlled while maintaining uniform tension. (Figure #5).

Variable Voltage Drive

BECAUSE there may be some objection to lineshaft power transmission and mechanical drives, the same elemental system is now reorganized to show the components required when employing another type of controlled drive system. This system uses variable voltage direct-current motors.

* * *

AGAIN the same fabric driving components are used, i.e. the driven letoff drive with float roll control, pull roll drive and windup roll drive with float roll control. However, the prime movers, the main power source and the control means are all electrical. The lineshafting is replaced by wiring and the mechanical variable speed transmissions are replaced by D.C. motors.

* * *

THE power source is a meter generator set which supplies controlled direct current voltages which are impressed upon the various driving motors at the individual units.

FOR the control of the unwinding and winding roll motors, the motion of the float sheaves is used to adjust a variable resistance rheostat, which in turn directly varies the speed of the winding or unwinding roll motors. A main voltage regulation rheostat at the motor generator set regulates the line voltages to all the driving. By selection of motors of matched characteristics, the variable voltage supply regulates all driving motors proportionately, thus controlling all speeds uniformly. The maximum limit of speed changes as it applies to the fabric velocity is, however, limited to approximately 4:1. The balance of the speed range adjustment must be reserved for compensation of roll diameter buildup. In addition to the fabric speed ranges, the roll buildup or let-down is usually in the order of 3:1, making an over-all demand drive range on the roll motors of 12:1, which is about the practical limit of this type of drive.

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IN such wide speed ranges, it is not only necessary to control and vary the impressed field voltage, but also to vary the motor armature voltage on the roll drive motors. This can be done very conveniently to suit the individual requirement.

* * *

NATURALLY, these systems possess many desirable features which compensate for the lack of wide speed ranges and the normal lack of control sensitivity at either end of the speed range. However, careful considerations must be given to horsepower, torques, and speed requirements to assure smooth fabric propulsion and handling.

* * *

HOWEVER, for a majority of operations variable voltage drives give sufficiently accurate and precise horsepower, speed and tension control to provide a very efficient drive with a good deal of adjustable sensitivity.

* * *

Fluid Hydraulic Drive

IN many fabric or wire handling operations, especially in fabric coating with organosols, explosive solvent vapor conditions occur. (Figure #6).

* * *

IN this hazardous operation, fully explosion-proof equipment is required by the National Board of Fire Underwriters. Often this requires elaborate electrical equipment at substantial cost.

* * *

LET us assume now, that our elemental system actually must operate through an adjustable range of 10:1 ratio from high to low fabric speed roll diameter buildup of 3:1, all in an explosive atmosphere.

* * *

THE driving arrangement shown in Figure #6 is the full fluid hydraulic drive, using circulating high pressure oil for power transmission, employing pumps instead of generators, and fluid motors in place of electric motors.

* * *

YOU will observe that all elemental components remain unchanged. The system consists of

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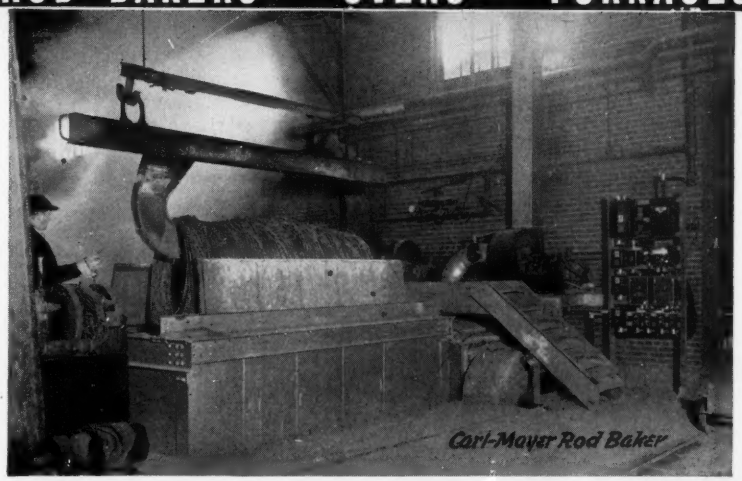

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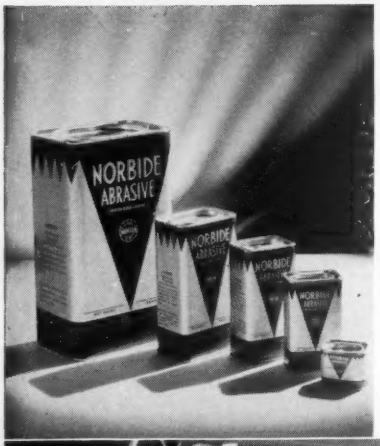

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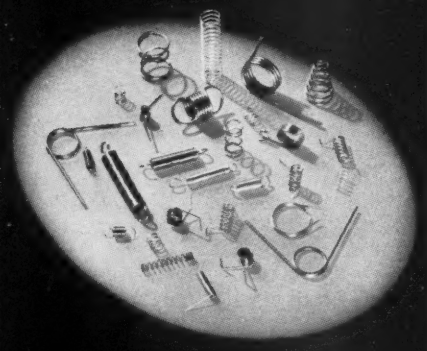

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letoff roll, float roll, coater or impregnator, dryer, main fabric pull rolls, windup float roll and windup roll. The changes in this system are only in the driving elements.

* * *

INITIALLY, motive power is developed by a main AC motor driving a hydraulic pump. This power is developed in the form of a volume of oil under controlled pressure. The volume of the oil flow, or the displacement of the main pump is used for basic speed control for the entire system. The oil pressure above that required to overcome pump and piping friction is used for horsepower, tension and torque control.

* * *

THIS fluid power, in the form of an uncompressible liquid under controlled pressure, is delivered to the various fluid motors in the system to furnish accurate speed and tension control.

* * *

VARIATIONS in the rate of fluid flow govern the speed directly and variations in pressure directly affect the horsepower or applied tension of the system. By controlling both pressure and fluid volume accurate speeds and tensions can be maintained.

* * *

THE system receives its primary speed and power input at the main variable displacement fluid pump, whose displacement is accurately controlled either by a handwheel operated valve or other remote control convenient to the design. This fluid power, is in turn piped to a fixed displacement fluid motor, which drives the main fabric drive rolls. These rolls propel the fabric at a constant velocity. Thus a direct variation of the main pump outlet volume directly varies the speed of the material through the system.

* * *

A suitable power takeoff on the main pull rolls is simultaneously used to drive a second hydraulic pump, whose main characteristic is constant displacement, that is, the pump is used to deliver a known and metered volume of oil directly to the windup drive fluid motor, through suitable fluid valving.

* * *

HOWEVER, in order to meet the decreasing speed requirement of the windup roll shaft, it becomes necessary to accurately control the fluid flow of the oil delivered to the fluid motor which drives the windup roll. To accomplish this result the simple expedient of a float roll is used. Here the displacement of the float roll is used to operate a throttling flow control valve, which integrates the volume of oil delivered to the roll windup motor in correct volume in proportion to the diameter of the windup roll.

* * *

DIAGRAMMATICALLY, counterweighted float rolls are indicated as the method of imposing tension on the material.

* * *

FOR driving the unwinding roll, a slightly different system is employed. Here the problem involves continuously increasing oil volumes again in proper relationship to diameter decrease as the material unwinds. To drive this roll a fixed displacement fluid motor receives its basic oil speed input from the main fluid source. To control the speed requirements, the float roll is suitably connected to hydraulic or Servo hydraulic flow valve which regulates the oil volume to the fixed displacement drive motor. By controlling fluid flow to this motor, correct acceleration to the roll is accomplished.

* * *

AGAIN in this system float rolls are used to impose tension on the fabric as well as to provide suitable speed control mechanisms.

* * *

BY deleting the float roll and by substituting the proper volume and pressure valving, the drives can be operated at constant horsepower and variable speed. The drive units lock elementally as shown on the slide.

* * *

COMPLETELY integrated hydraulic drives have many distinctive advantages including maximum torque at low or zero speeds, wide speed ranges and very smooth acceleration and deceleration characteristics. They present a flexible and ideal drive for explosive atmospheres which are often encoun-

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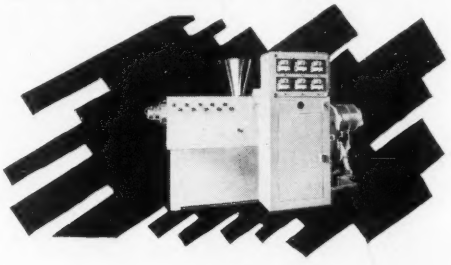

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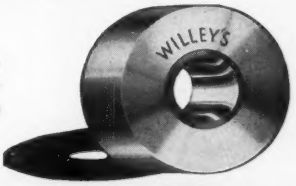

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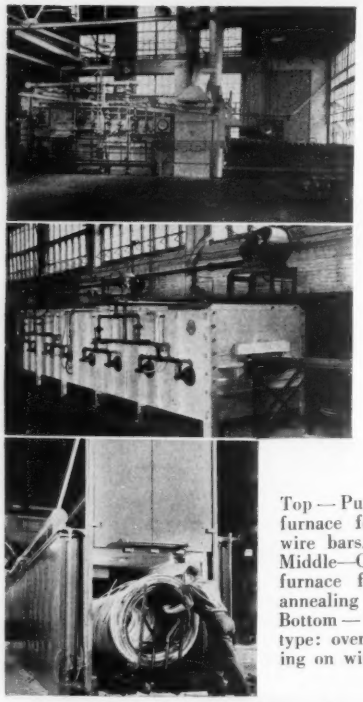

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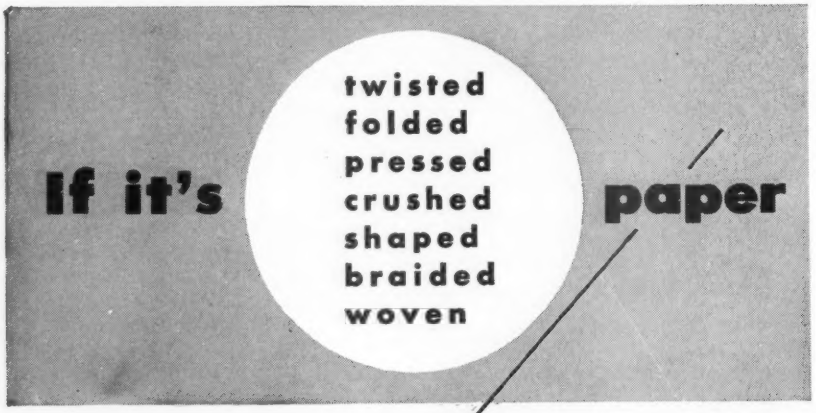

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tered in coating and similar operations.

* * *

Electronically Controlled Drive

ANOTHER basic method of controlling integrated controlled drives is the complete electronically controlled drive. Essentially in schematic appearance it would not differ greatly from the variable voltage drive as shown on a previous illustration. Its basic difference is the control medium. In electronically controlled drives, the control voltage is not regulated by rheostats but by several basic units such as saturable core reactors or variable condensers or other variable controlling electrical means. All of these elements rely upon fabric displacement to vary the capacitance or impedence of a coil or condenser to control the impressed voltage on the grid of an electronic tube. By variation of these measuring circuits more or less current is passed through the controlled thyratron tube to alter the control circuit voltage on the main power circuit.

* * *

AS in the case of the hydraulic drive, the dancer roll can be completely eliminated by providing constant horsepower, variable torque and variable speed drive. This requires accurate voltage and amperage control. However, as mentioned, most winding and tensioning applications require such a small amount of actual horsepower, that its accurate control becomes a relatively serious problem. Where high material tensions are involved, the horsepower is in direct proportion to the power units that are available. However, in very thin film or in very fine wire, the horsepower that is required for tension and propelling purposes is negligible and accurate control is a problem, not primarily from the standpoint of equipment size but principally from the standpoint of the speed control.

* * *

ELECTRONIC drives, like all other forms of driving mediums, can be more conveniently organized by using these drives at variable speed and variable horsepower. This

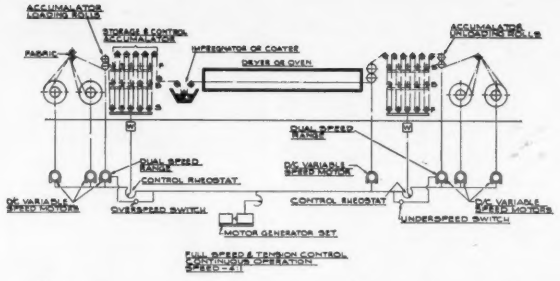

Figure 7.

* * * * *

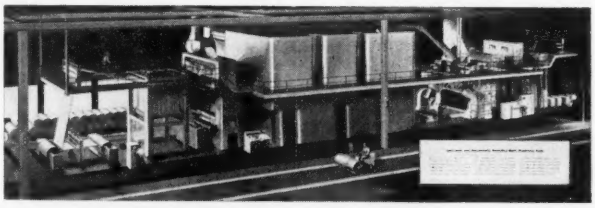

Figure 8.

* * * * *

requires float rolls and added counterweight tensions. In this case the tension on the material is constantly applied mechanically. The drive, therefore, must possess ample horsepower capacity to overcome the tension imposed plus the friction in the system. Its only requirement is speed control and this is usually the easiest part of the material handling operation.

* * *

Continuous Material System

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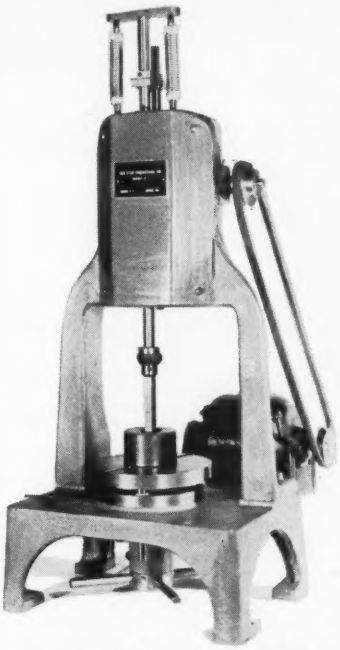

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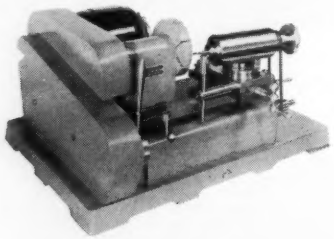

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its secondary tension control have been considered. In very many operations where high processing speeds are required or where the nature of the operations is such that the material cannot be stopped, a continuous processing operation is required to change unwinding or winding rolls. Figure #7 shows an automatic and continuous operation at its best embodying all of the features of low attendant operation, high sustained material speeds and precise speeds and tension controls.

* * *

THE system remains basically unchanged except that the float roll is enlarged to become a storage accumulator and the operating characteristics of the drive motors are suitably altered to accommodate the new driving condition.

* * *

IN the non-continuous handling systems, the material is stopped to splice a new roll or cut off the fully completed roll of the processed material. In a continuous handling system, as shown, the material travels at processing speeds, and the splicing of a new roll or the cutting of a full roll is accomplished simultaneously without interruption of the fabric travel.

* * *

ONE of the several devices used to accomplish this operation is the control festoon accumulator, one of which is shown on either end of the system.

* * *

IN principal, the accumulator storage festoon acts like a control festoon with the additional feature of greatly increased fabric capacity. It consists essentially of a battery of fixed top idler rolls, which are stationarily positioned, and the lower group of which float and are free to rise and fall as a group, in direct proportion to the difference between the amount of fabric paid in and fabric paid out of the roll system. It is a web handling unit so designed that it has storage capacity for the accumulation of the variable amounts of fabric.

* * *

IN operation, the unwinding accumulator is loaded with fabric by the pair of dual range DC motor driven rolls, which run normally at synchronous fabric speed. By

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this, we mean that these rolls deliver fabric from the unwind stand at a rate generally equal to the speed of the main pull rolls. Under this condition the lower group of floating rolls remain in the same relative position. As the unwinding rolls near the end, the operator controls the over-speed switch, speeding up these rolls and simultaneously removing them from rheostat control. As these rolls increase speed, more fabric is driven into the accumulator than the main pull rolls remove and the roll platform lowers into the accumulator body. Finally the fabric roll is unwound and the over-speed roll motor stops automatically, holding the end of the fabric. The trailing fabric end is sewn or spliced to the new roll. In the interim, the fabric has been leaving the accumulator lower roll platform. After the splice, the roll motor is passed back to the rheostat control and the system is again in normal position.

* * *

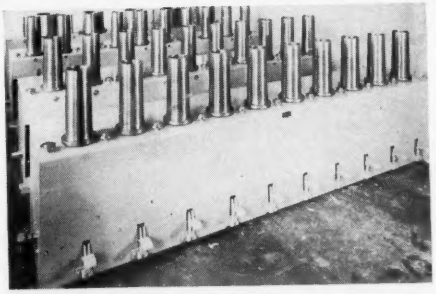
AS mentioned, the accumulator platform drops as more fabric is loaded and raises when it is withdrawn from the opposite end of the accumulator. This movement of the platform, as the lower roll group is called, is used to operate a control rheostat so that the accumulator frame travel is used to actually synchronize the speed of the festoon loading rolls. Its function is that of an enlarged control loop.

* * *

AS in the case of the float roll, the accumulator platform is used to impose counterweight loading on the fabric. However, because of the usual large number of fabric passes, dead weight tension additions present a space problem and air or hydraulic loading is applied to the lower rolls. This type of tension control on the accumulator platform does not impair or alter the functions of the mechanism in storing relatively long lengths of fabric. In that respect, the function of the accumulator is basically the same as the single control loop.

* * *

IN this system, two accumulators are used; one on either end of the system. In actual operation, the accumulators usually run with the floating roll in the upper posi-



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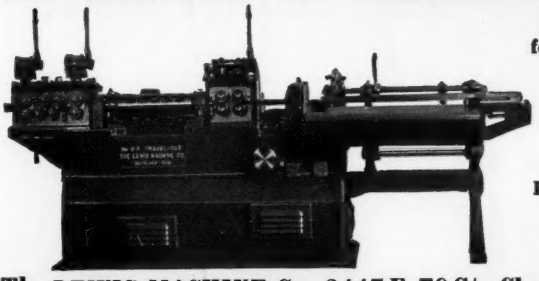

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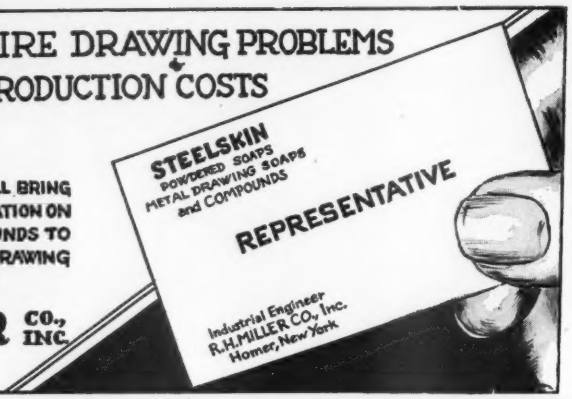

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tion so that more fabric can be easily loaded into the accumulator from either end. In both cases the primary function is to store fabric while the splice or cutoff is being made and to present that fabric in convenient paying-out conditions at uniform velocity and speed conditions.

* * *

BECAUSE of the somewhat involved physical arrangement of the equipment and the interconnection of the various drive units, a system of this type is practical only on variable voltage, electronic or hydraulically controlled drive systems.

* * *

FIGURE #8 shows a very large system embodying continuous operation and accumulation. This particular system is one of the largest installations of its kind in the world.

* * *

BROADLY speaking, we have been taking a very brief view of a small portion of the web material handling field. Only one simple problem has been stated, and several solutions have been suggested. There are, naturally, many other systems, which have advantages peculiar to themselves and which, because of their special nature, are seldom used.

* * *

IN such short space it is impossible to include horsepower, speed computations, or any detailed data to support any of the developed designs. We have, in passing, emphasized speed synchronization and shown how relatively simple these problems really are.

* * *

ALL the illustrations have shown basic systems which are in successful operation.

* * *

OBVIOUSLY, it shows clearly what a wide choice of driving systems is available to serve a very wide operating condition range and what can be accomplished in tensioning, processing and winding control of web materials, at least with respect to main drive elements available.

* * *

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LABOR RELATIONS

By John B. Stone
Washington, D. C.

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RECENT actions by some branches of the Federal Government have taken the question of Communists in the labor movement out of the field of politics and placed it directly in the realm of plant management.

* * *

IF present trends in Washington continue, this question probably will become one of vital importance to many plant managers including those who direct the operations of wire and wire products production.

* * *

AT the same time a wave of inter-union raiding which was originally inspired by the provision of the Taft-Hartley Law requiring heads of unions to sign affidavits that they are not Communists, has

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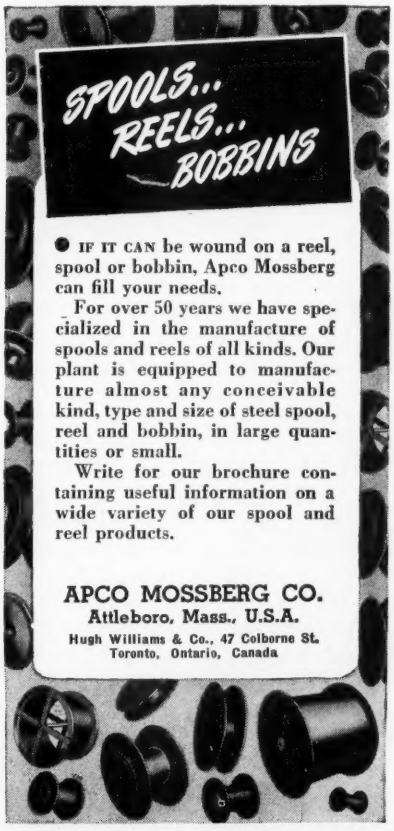

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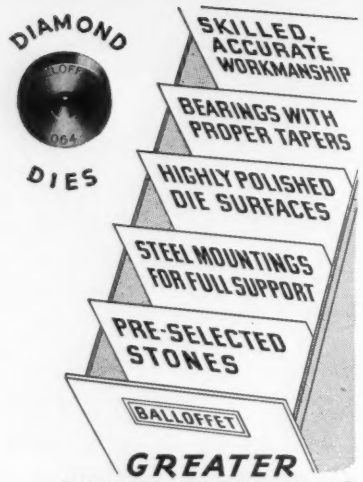

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now passed beyond political limits and shows every sign of engulfing the entire American labor movement.

* * *

SUCH an epidemic of raiding by one union on the plants already organized by a sister union would bring headaches to management as great or greater than the Communist question posed by the Government.

* * *

THE reecnt order by David E. Lillienthal, chairman of the Atomic Energy Commission here in Washington black listing the United Electrical Radio and Machine Workers Union, third largest affiliate of the Congress of Industrial Organizations, already has run into a head-on collision with the carefully worked out labor policies of the General Electric Company.

* * *

ALTHOUGH the General Electric Company has no love for Communists and certainly no desire to employ them in its plants, the National Labor Relations Board already had certified the United Electrical workers as the collective bargaining agent in many GE plants. The Lillienthal edict in no way modified the ruling of the NLRB and many UE-GE contracts will run through 1950.

* * *

BUT Lillienthal, in an outright order to GE, demanded that the company cease negotiations with the UE for the atomic energy plant to be operated by GE near Schenectady, N. Y.

* * *

THUS the U. S. Government forces General Electric to carry on its business with two unions instead of one. The Atomic Energy Commission, one "hand" of the Government, said "No bargaining with UE". The National Labor Relations Board, another hand of the Government, says "You must bargain with UE."

* * *

CHARLES E. Wilson, president of GE complains that the Government had refused to give him any evidence that members of UE seek the overthrow of the Government of the United States and that without such evidence he is powerless to refuse to bargain with UE.

* * *

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THE Taft-Hartley law in no way prohibits negotiations with unions which have failed to sign the affidavits. It merely states that a union whose officers have failed to sign cannot make use of the facilities of the NLRB. Thus the employer is in the middle while the Government moves in two directions simultaneously.

* * *

INDICATIONS that many additional employers including a great many manufacturers of wire and wire products may be caught in the same dilemma is seen by well informed Washington observers in the increasing role the Government is playing in industry through plans for mobilization in case of war.

* * *

THE Munitions Board, the War Mobilization Board, and the National Security Resources Board all are exercising a constantly growing influence over manufacturing in all lines.

* * *

THROUGH the increased "preparedness" program involving millions of dollars in production of munitions, airplanes, and war equipment the Munitions Board is gaining a position where it can lay down absolute production policies.

* * *

THE War Mobilization Board and the National Security Resources board are both exercising similarly augmented powers. The National Security Resources Board plans to extend its program of "phantom orders" from the machine tool line, where it has already placed one billion dollars worth of these orders to become real when war comes, into many other lines. Electronics and radar will be one of the first groups included.

* * *

THUS these three Government boards will be in a position to lay down the law in the same way as did Chairman Lillienthal of the Atomic Energy Commission. Yet there is at present no sign that the NLRB will be empowered to act in accordance with the edicts of these other branches of the Government. It appears that manufacturers are going to be forced to do a lot of legalistic tight rope walking in labor relations in the near future.

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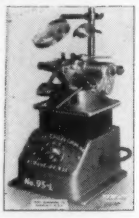

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THE refusal of some big unions, like the United Mine Workers, the United Electrical Workers and the United Steel Workers to sign the non-Communist affidavits set off a nation-wide campaign of raiding.

* * *

AT first the victims, with the exception of the Steel Workers, were those who had failed to sign the affidavits. Mine Mill and Smelter Workers, which had not signed, was raided by United Auto Workers and the Shipbuilding Workers, both fellow CIO members who had had their officers sign. The Farm Equipment Workers, which had not signed, took a beating from the Auto Workers.

* * *

BUT the fever spread. The most glaring case of union raiding recently has been that of the AFL Teamsters under the West Coast leadership of Dave Beck. It took over the entire membership at the Seattle Boeing plant from the International Association of Machinists, which was on strike. The Machinists was the first big union to sign and file the affidavits.

* * *

VETERAN observers see in this situation the beginning of a huge labor fight between Beck, who has his eye on the presidency of the AFL and Walter Reuther, present head of the United Auto Workers, who wants to succeed Phil Murray as president of the CIO.

* * *

THEY warn that the fight may involve most labor unions in the country before it is finished and will leave a wide wake of managerial headaches.

* * *

Evaluation of Pickling Inhibitors From the Standpoint of Hydrogen Embrittlement. II. Acid Pickling of Carbon Steel

(*Continued from page* 1053)

IN Figure 15, the behavior of Reagent XV shows marked repression of embrittlement, and at concentrations considerably lower than the minimum proprietary addition. In other respects this is also a most promising inhibitor, having a surpassing reduction of metal attack. However, we are only concerned here with its effect upon hydrogen embrittlement.

* * *

Conclusion

SUMMARIZING briefly the principal disclosures of this research:

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1. By means of the constant-rate single-bend test, a quantitative evaluation has been made of a number of the most widely used commercial pickling inhibitors on the basis of their effect upon embrittlement resulting from the pickling of mild steel in sulfuric acid;
2. Of fifteen reagents studied, seven fail to prevent embrittlement regardless of the concentration of reagent employed;
3. Four do prevent embrittlement, but only dependably at concentration greater than the common proprietary addition;
4. Of the remaining four, each satisfactorily prevents embrittlement, and at concentrations safely less than the minimum of the common proprietary range;
5. Of these four acceptable reagents, one is a recently available product which is specially designed for the prevention of hydrogen embrittlement in both mild and alloy steel alike.

* * *

IN addition to these specific disclosures, considerable interest attaches to a comparison of the present data with those reported for stainless steel in the foregoing paper[1]:

1. Whereas it is the rule for the inhibitors to increase the embrittlement of the stainless steels even beyond that caused by raw acid, this is the exception with mild steel;
2. Among the four inhibitors classed as acceptable for mild steel, only one—the specially designed Reagent XV—can be recommended for mild steel and stainless steel alike;
3. Of the three remaining inhibitors in this acceptable group for mild steel: (1) Reagent IX is the only one showing any improvement whatsoever in the pickling of stainless steel, and

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that too slight to allow classing it with Reagent XV; (2) Reagent III is in the class which does not alter the embrittlement of stainless steel beyond that caused by the raw acid; (3) Reagent XIII is among those which markedly increase the embrittlement of stainless steel;

4. **With the single exception of Reagent IV, which has no effect on the embrittlement of stainless steel, all inhibitors which do not prevent the embrittlement of mild steel throughout their proprietary range (Classes I and II) cause increased embrittlement in stainless steel.**

* * *

IN the present research one therefore finds the answer to the question raised by the preliminary paper[2] whether the unexpected results with stainless steel also apply to carbon steel.

* * *

TO a great extent they do, and this raises important practical issues with regard to the use of inhibited acids where such hydrogen-caused defects as brittleness in wire, blisters in sheet and strip, and pinholes and related defects in subsequently applied coatings are concerned.

* * *

AS for the points of difference, which are also marked, a particularly interesting problem for fundamental research is indicated in explaining the phenomenal role that the chromium content of the steel seems to play in causing **increased** hydrogen absorption when an inhibiting reagent is present in the pickling solution.

* * *

IN fact, the data call attention to an entirely new aspect of surface chemistry to be explored with respect to the surprising independence of hydrogen absorption and total hydrogen produced — in other words, embrittlement and metal attack. A preliminary approach to the problem is described in the third paper of the present series in which these same reagents are studied for both steels under the conditions of electrolytic pickling[3].

Acknowledgment

Acknowledgment is made to the Office of Naval Research for its support of the fundamental research program on gas-metal studies from which the present paper stems as a special study.

* * *

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Index To Advertisers

A

Acrometal Products, Inc. 1082
Ajax Industrial Supplies, Inc. 1079
Aluminum Company of America 1023
American Chemical Paint Company 1063
American Insulating Machinery Company 1075
American Steel & Wire Company 1029
American Woodworking Company 1082
Angier Corporation, The 1078
Apco Mossberg Company 1077

B

Balloffet Dies & Nozzle Company, Inc. 1078
Bethlehem Steel Company 1010
Bick, Hans C., Inc. 1079
Black Industries, Inc. 1019
Boyd, Charles P., Corp. 1079
Bridge Manufacturing, Inc., The 1069

C

Carboloy Company, Inc. 1009
Carl-Mayer Corp., The 1069
Carlson Company 1082
Champion Diamond Company, Inc. 1079
Chase Brass & Copper 1013
Cleveland Tramrail Division of the
Cleveland Crane & Engineering Company 1081
Cochaud Wire Die Corporation 1079
Columbia Steel Company 1029
Continental Steel Corp. 1075
Copperweld Steel Corp. 1073
Crepe-Kraft Company. The
Division of National Waterproof Papers, Inc. 1080

D

Davis, R. L. Electric Co. 1026
Durant Manufacturing Company 1080
DuPont, E. I., de Nemours, Company 1021
Durkee Manufacturing Company 1076

E

Eastern Carbide Corp. 1062
Eastern Tungsten Carbide Company 1079
Eastwood-Nealley Corp. 1077
Eisler Engineering Company 1080
Electric Furnace Company ..... Back Cover
Emory, Robert J. Company 1079
Entwistle, James L., Company 1012

F

Firth-Sterling Steel & Carbide Company 1036
Fort Wayne Wire Die, Inc. 1079
Furnace Engineers, Inc. 1081

G

General Electric Company, The 1014
Glader, Wm., Machine Works 1059
Gordon, Clark, E., Inc. 1081

H

Haveg Corporation 1081
Hayes, C. I., Inc. 1064
Heil Process Equipment Corp. 1080
Hoosier Carbide Die, Inc. 1079
Howsam Spool Company 1075
Hubbard Spool Company 1022
Hudson Wire Company 1016
Hughesville Machine & Tool Company 1081

I

Indiana Wire Die Company 1079
Industrial Ovens, Inc. 1081

J

Johnson Steel & Wire Company, Inc. 1070

K

Kelly Wire Die Corp. 1079
Keystone Steel & Wire Company 1058

L

Lancaster, Allwine & Rommel 1082
Lewis, K. B. 1082
Lewis, Machine Company, The 1075

M

Magnus Chemical Company 1025
Malin & Company, The 1081
Martin, Glenn L., Company 1011
Metal & Thermit Corp. 1074
Metal Carbides Corporation 1080
Micro Products Company 1057
Miller, R. H., Company, Inc. 1076
Modern Plastic Machinery Company 1071
Montgomery Company, The 1080
Morgan Construction Company 1034
Mossberg Pressed Steel Corp. 1079

N

National Annealing Box Company 1082
National Machinery Exchange 1082
New England Butt Company 1028
New England Wire Die Company 1079
Niles Steel Products Div., Republic Steel Corp. 1035
Nopco Chemical Company 1060
Norton Company, The 1070

O

Oakite Products, Inc. 1077
O'Neil-Irwin Manufacturing Company 1081
Owens-Corning Fiberglas Corp. 1018

P

Pacific Coast Borax Company 1077
Parkin, Wm. M., Co., The 1081
Paramount Wire Company 1081
Pittsburgh Cut Wire Cut Company 1068
Platt Brothers & Company, The 1080
Porter, H. K., Inc. 1077
Potter, Neil C. 1080

R

Red Star Engineering Corp. 1073
Robertson, John, Co., Inc. 1020
Rockwell, W. S., Company 1072
Roebling's John A., Sons Company 1015
Roos Tool & Manufacturing Company 1074
Ross, J. O., Engineering Corp. 1080
Royle, John & Sons 1066
Ruesch H. J., Machine Company 1079
Rusch Wire Die Corporation 1079

S

Sauereisen Cement Company 1081
Sciaky Bros., Inc. 1061
Scott Testers, Inc. 1080
Scudder, E. J., Foundry & Machine Company 1080
Siogren Tool and Machine Co., Inc. 1067
Sleeper & Hartley, Inc. 1081
Standard Industrial Compounds Co., Inc. 1027
Steel Equipment Company 1065
Surface Combustion Corp. 1081
Swift & Company 1031
Syncro Machine Company 1030

T

Tennessee Coal. Iron & R. R. Company 1029
Trauwood Engineering Company 1081
Twitchell, E. W., Inc. 1072

U

U. S. Steel Export Company 1029

V

Vascoloy-Ramet Corp. 1032
Vaughn Machinery Company ..... Front Cover
Vianney Wire Die Works 1078

W

Waterbury Farrel Foundry & Machine Co. 1081
Watson Machine Company ..... Inside Back Cover
Wayne Wire Die Company 1078
Wean Equipment Corp. ..... Inside Front Cover
Wickwire Spencer Steel Division
Colorado Fuel & Iron Corp. 1024
Willey's Carbide Tool Company 1071
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New England Wire Die Co., Worcester, Mass.
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.
Wayne Wire Die Co., Hillside, N. J.

DIAMOND TOOLS—
Carboloy Co., Inc., Detroit, Mich.
Eastern Tungsten Carbide Co., Newark, N. J.
Firth-Sterling Steel & Carbide Corp., Mc-Keesport, Pa.
Indiana Wire Die Co., Fort Wayne, Ind.
Metal Carbides Corporation, Youngstown, Ohio.
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.
Wayne Wire Die Co., Hillside, N. J.

DIES—Cold Heading
Carboloy Co., Inc., Detroit, Mich.
Eastern Carbide Corp., New Rochelle, N. Y.
Firth-Sterling Steel & Carbide Corp., Mc-Keesport, Pa.
Hoosier Carbide Die Co., Ft. Wayne, Ind.
Indiana Wire Die Co., Fort Wayne, Ind.
Metal Carbides Corporation, Youngstown, Ohio.
Vascoloy-Ramet Corp., No. Chicago, Ill.

DIES—Diamond
Ajax Industrial Supplies, Inc., Fort Wayne, Ind
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N.J.
Cochaud Wire Die Corp., New York, N. Y.
Ft. Wayne Wire Die, Inc., Fort Wayne, Ind.
Indiana Wire Die Co., Fort Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
New England Wire Die Co., Worcester, Mass.
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.
Vianney Wire Die Wks., New York, N. Y.
Wayne Wire Die Co., Hillside, N. J.

DIES—Eyelet
Hoosier Carbide Die Co., Ft. Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.

DIES—Lead Extrusion
Carboloy Co., Inc., Detroit, Mich.
Eastern Tungsten Carbide Co., Newark, N. J.
Firth-Sterling Steel & Carbide Corp., Mc-Keesport, Pa.
Metal Carbides Corporation, Youngstown, Ohio.
Robertson, John, Co., Brooklyn, N. Y.
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.
Wayne Wire Die Co., Hillside, N. J.
Willey's Carbide Tool Co., Detroit, Mich.

DIES—Pointing
Sjogren Tool and Machine Co., Auburn, Mass.

DIES—Repairs & Re-Cutting
Ajax Industrial Supplies Inc., Fort Wayne, Ind.
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N.J.
Carboloy Co., Inc., Detroit, Mich.
Cochaud Wire Die Corp., New York, N. Y.
Eastern Tungsten Carbide Co., Newark, N. J.
Firth-Sterling Steel & Carbide Corp., Mc-Keesport, Pa.
Ft. Wayne Wire Die, Inc., Fort Wayne, Ind.
Indiana Wire Die Co., Fort Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides, Corporation, Youngstown, Ohio.
New England Wire Die Co., Worcester, Mass.
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Wks., New York, N. Y.
Wayne Wire Die Co., Hillside, N. J.
Willey's Carbide Tool Co., Detroit, Mich.

DIES—Rod and Tube Drawing
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N.J.
Carboloy Co., Inc., Detroit, Mich.
Eastern Carbide Corp., New Rochelle, N. Y.
Eastern Tungsten Carbide Co., Newark, N. J.
Firth-Sterling Steel & Carbide Corp., Mc-Keesport, Pa.
Indiana Wire Die Co., Fort Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corporation, Youngstown, Ohio.
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Wks., New York, N. Y.
Willey's Carbide Tool Co., Detroit, Mich.

WHERE TO BUY, Continued

DIES—Special Shapes, Etc.
Eastern Carbide Corp., New Rochelle, N. Y.
Hoosier Carbide Die Co., Ft. Wayne, Ind.
Indiana Wire Die Co., Fort Wayne, Ind.
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.

DIES—Tantalum Carbide
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N.J.
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel & Carbide Corp., Mc-Keesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corporation, Youngstown, Ohio.
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Wks., New York, N. Y.

DIES—Tubing
Hoosier Carbide Die Co., Ft. Wayne, Ind.
Rusch Wire Die Corp., Croton-on-the-Hudson, N.Y.

DIES—Tungsten Carbide
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N.J.
Carboloy Co., Inc., Detroit, Mich.
Eastern Carbide Corp., New Rochelle, N. Y.
Firth-Sterling Steel & Carbide Corp., Mc-Keesport, Pa.
Hoosier Carbide Die Co., Ft. Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides, Corporation, Youngstown, Ohio.
Rusch Wire Die Corp. Croton-on-the-Hudson, N.Y.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Wks., New York, N. Y.
Wayne Wire Die Co., Hillside, N. J.
Willey's Carbide Tool Co., Detroit, Mich.

DRAW BENCHES—
(See MACHINERY—Draw Benches)

DRUMS—Flange Steel
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.

DRUMS—Vulcanizing
Mossberg Pressed Steel Corp., Attleboro. Mass.
Watson Machine Co., The, Paterson, N. J.

DRYING EQUIPMENT—
Carl-Mayer Corp., The, Cleveland, Ohio.
Industrial Ovens, Inc., Cleveland, Ohio.
Modern Plastic Machinery Corp., Lodi, N. J.
Rockwell, W. S., Co., Fairfield, Conn.
Ross, J. O., Engineering Corp., New York, N.Y.

ENGINEERS—Consulting Spring Design
Carlson Co., The, New York, N. Y.

ENGINEERS—Consulting Wire Mill
Lewis, Kenneth B., Worcester, Mass.

EQUIPMENT—Insulation Testing
Davis, R. L., Elec. Co., Wallingford, Conn.
Entwistle, James L., Co., Pawtucket, R. I.

EYELETS—Brass or Zinc
Platt Bros., & Co., The, Waterbury, Conn.

FLUXES—Soldering
American Chemical Paint Co., Ambler, Pa.

FOAM PRODUCING COMPOUNDS—
American Chemical Paint Co., Ambler, Pa.
Parkin, Wm. M. Co., Pittsburgh, Pa.

FRICTION PAY-OFF STANDS—
Industrial Ovens, Inc., Cleveland, Ohio.

FURNACES—Annealing
Ajax Electric Co., Inc., Philadelphia, Pa.
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, Ohio.
Furnace Engineers, Inc., Pittsburgh, Pa.
Hayes C. I., Providence, R. I.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corp., Toledo, Ohio.
Trauwood Engr. Co., Cleveland, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Automatic
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, Ohio.
Surface Combustion Corp., Toledo, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Brazing
Electric Furnace Co., Salem, Ohio.
Firth-Sterling Steel & Carbide Corp., Mc-Keesport, Pa.
Rockwell, W. S., Co., Fairfield, Conn.

FURNACES—Bright Annealing
Electric Furnace Co., Salem, Ohio.
Furnace Engineers Inc., Pittsburgh, Pa.
Surface Combustion Corp., Toledo, Ohio.
Rockwell, W. S., Co., Fairfield, Conn.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Electric
Eisler Engineering Co., Newark, N. J.
Electric Furnace Co., Salem, Ohio.
Hayes, C. I., Providence, R. I.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corp., Toledo, Ohio.
Trauwood Engineering Co., The, Cleveland, Ohio

FURNACES—Galvanizing Equipment
Ajax Electric Co., Inc., Philadelphia, Pa.
Electric Furnace Co., Salem, Ohio.
Furnace Engineers, Inc., Pittsburgh, Pa.
Rockwell, W. S., Co., Fairfield, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Surface Combustion Corp., Toledo, Ohio.
Trauwood Engineering Co., The, Cleveland, Ohio
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Hard'ing & Temp'ing
Ajax Electric Co., Inc., Philadelphia, Pa.
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, Ohio.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corp., Toledo, Ohio.
Trauwood Engr. Co., The, Cleveland, Ohio.

FURNACES—Lead Melting
Electric Furnace Co., Salem, Ohio.
Furnace Engineers, Inc., Pittsburgh, Pa.
Robertson, John, Co., Brooklyn, N. Y.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Non-Oxidizing
Ajax Electric Co., Inc., Philadelphia, Pa.
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, Ohio.
Furnace Engineers, Inc., Pittsburgh, Pa.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Normalizing
Ajax Electric Co., Inc., Philadelphia, Pa.
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, Ohio.
Furnace Engineers, Inc., Pittsburgh, Pa.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Pot (Oil, Gas, Electric)
Ajax Electric Co., Inc., Philadelphia, Pa.

FURNACES—Resistance Heating, Strand
Trauwood Engineering Co., Cleveland, Ohio

FURNACES—Salt Bath
Ajax Electric Co., Inc., Philadelphia, Pa.
Electric Furnace Co., Salem, Ohio.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corporation, Toledo, O.
Trauwood Engineering Co., The, Cleveland, Ohio

FURNACES—Wire, Strip & Sheet
Carl-Mayer Corp., The, Cleveland, Ohio.
Eisler Engineering Co., Newark, N. J.
Electric Furnace Co., Salem, Ohio.
Furnace Engineers, Inc., Pittsburgh, Pa.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corporation, Toledo, O.
Trauwood Engineering Co., The, Cleveland, Ohio
Wilson, Lee, Engr. Co., Cleveland, Ohio.

GALVANIZING EQUIPMENT—
Steel Equipment Co., Cleveland, Ohio.
Wean Equipment Corp., Cleveland, Ohio.

GALVANIZING KETTLES—
National Annealing Box Co., Washington, Penna.

GRINDERS—Roll
Norton Co., The, Worcester, Mass.

HAMMERS—Swaging
Sjogren Tool and Machine Co., Auburn, Mass.

HOISTS—Electric Travelling
Cleveland Tramrail Div. of The Cleveland Crane & Engineering Co., Wickliffe, Ohio.

HOOKS—Pickling & Lining
Gordon, Clark E., Detroit, Mich.

INHIBITORS—Pickling
American Chemical Paint Co., Ambler, Pa.
Oakite Products, Inc., New York, N. Y.
Parkin, Wm. M. Co., Pittsburgh, Pa.

INSULATING LACQUERING SYSTEMS—Continuous
American Insulating Mach'y. Co., Phila., Pa.
Industrial Ovens, Inc., Cleveland, Ohio.

INSULATING MATERIALS—
Du Pont de Nemours, E. I., Co., Wilmington, Del.
General Electric Co., Schenectady, N. Y.
Martin, Glenn L., Company, Baltimore, Md.
Owens Corning Fiberglas Corp., Toledo, O.
Standard Varnish Wks., Staten Island, N. Y.
Twitchell, E. W., Philadelphia, Pa.

LATHES—Die Reaming
Carboloy Co., Inc., Detroit, Mich.
Firth Sterling Steel & Carbide Co., McKeesport, Pa.
Morgan Construction Co., Worcester, Mass.
Roos, Tool & Mfg. Co., Montclair, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.

LIME—
Warner Co., Philadelphia and Bellefonte, Pa.

LININGS—Acid and Alkali Proof
Haveg Corp., Newark, Del.
Heil Processs Equipment Corp., Cleveland, Ohio.
Sauereisen Cements Co., Pittsburgh, Pa.

LUBRICANTS—For Metal Cutting, Stamping and Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Inc., Homer, N. Y.
Oakite Products, Inc., New York, N. Y.
Standard Industrial Compounds Co., Chicago, Ill.

LUBRICANTS—Wire Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Bick, Hans C., Inc., Reading, Pa.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Homer, N. Y.
Oakite Products, Inc., New York, N. Y.
Potter, Neil C., Newark, N. J.
Standard Industrial Compounds Co., Chicago, Ill.
Swift & Company, Chicago, Ill.

MACHINERY—Armoring (Cable, Wire Hose)
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Braiding
Mossberg Pressed Steel Corp., Attleboro, Mass.
New England Butt Co., Providence, R. I.
Wire & Textile Mach'y, Inc., Pawtucket, R. I.

MACHINERY—Brazing
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Bunching
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Bundling, Scrap
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Cable, Electric
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Chain Making
Nilson, A. H. Machine Co., The, Bridgeport, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Cable, Rope Closing
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

WHERE TO BUY, Continued

MACHINERY—Coil Winding
Rockwell, W. S., Co., Fairfield, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Coilers
Eisler Engineering Co., Newark, N. J.
Entwistle, Jas. L. Co., Pawtucket, R. I.
Morgan Construction Co., Worcester, Mass.
National Machinery Exchange (used), New York, N. Y.
New England Butt Co., Providence, R. I.
Ruesch, H. J. Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Watson Machine Co., Paterson, N. J.
Wean Equipment Corp., Cleveland, Ohio.
Wire & Textile Machinery Inc., Pawtucket, R. I.

MACHINERY—Copper Wire Drawing and Rolling
Aetna Standard Eng'g Co., The, Youngstown, O
American Insulating Mach'y Co., Phila., Pa.
National Machinery Exchange (used), New York, N. Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.

MACHINERY—Covering Wire
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Royle, John & Sons, Paterson, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Cutting
Eisler Engineering Co., Newark, N. J.
Lewis Machine Co., The, Cleveland, Ohio.
National Mach'y Exch. (Used), New York, N.Y.
Nilson Machine Co., A. H., Bridgeport, Conn.
Porter, H. K. Inc., Everett, Mass.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Die Making
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel & Carbide Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Roos Tool & Mfg. Co., Montclair, N. J.
Wayne Wire Die Co., Hillside, N. J.

MACHINERY—Draw Benches
Aetna Standard Eng'g Co., The, Youngstown, O.
Morgan Construction Co., Worcester, Mass.
Ruesch, H. J., Machine Co., Newark, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Edging
Wean Equipment Corp., Cleveland. Ohio.

MACHINERY—Enameling
American Insulating Mach'y Co., Phila., Pa.
Industrial Ovens, Inc., Cleveland. Ohio.
Rockwell, W. S., Co., Fairfield, Conn.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Extruding
Modern Plastic Machinery Co., Lodi, N. J.
Robertson John, Co., Brooklyn, N. Y.
Royle, John, & Sons, Paterson, N. J.
Wire & Textile Machinery, Inc., Pawtucket, R. I

MACHINERY—Fence
Glader, Wm., Machine Works, Chicago, Ill.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Filament Coil Winding
Eisler Engineering Co., Newark, N. J.

MACHINERY—Flat Wire
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Galvanizing
(See Galvanizing Equipment)

MACHINERY—Galvanizing Wire
Sleeper & Hartley, Inc., Worcester, Mass.
Steel Equipment Co., Cleveland, Ohio.
Vaughn Machinery Co., Cuyahoga Falls, O.
Wean Equipment Corp., Cleveland, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

MACHINERY—Gang Winders
Entwistle, Jas. L. Co., Pawtucket, R. I.
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Grinding
Norton Co., Worcester, Mass.

MACHINERY—Insulating
American Insulating Mach'y Co., Phila., Pa.
Modern Plastic Machinery Co., Lodi, N. J.
New England Butt Co., Providence, R. I.
Royle, John & Sons, Paterson, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Lead Encasing Presses, etc.
Robertson, John Co., Brooklyn, N. Y.

MACHINERY—Lead Stripping
Robertson, John Co., Brooklyn, N. Y.

MACHINERY—Lock Washer
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Magnet Wire
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Material Handling
Cleveland Tramrail, Div. of The Cleveland Crane & Engineering Co., Wickliffe, O.

MACHINERY—Measuring Wire & Cable
Durant Mfg. Co., Milwaukee, Wis.
Entwistle, Jas. L. Co., Pawtucket, R. I.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Nail and Tack
Black Industries, Cleveland, Ohio
Glader, Wm., Machine Works, Chicago, Ill.
National Mach'y Exch. (Used), New York, N.Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Panning
American Insulating Mach'y Co., Phila., Pa.
Syncro Machine Co., Perth Amboy, N. J.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Pickling
Gordon, Clark E., Detroit, Michigan.

MACHINERY—Pointing
Aetna Standard Eng'g Co., The, Youngstown, O.
Morgan Construction Co., Worcester, Mass.
National Mach'y Exch. (Used), New York, N.Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry & Mach. Co., Trenton, N.J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Rod Mill
Morgan Construction Co., Worcester, Mass.
Ruesch, H. J., Machine Co., Newark, N. J.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Rolling Mill
Morgan Construction Co., Worcester, Mass.
National Mach'y Exch. (Used), New York, N.Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Rubber Insulating
Royle, John & Sons, Paterson, N. J.
Wire & Textile Machinery, Inc., Pawtucket, R. I.

MACHINERY—Rubber Tubing and Straining
New England Butt Co., Providence, R. I.
Royle, John, & Sons, Paterson, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Screw Wire
National Mach'y Exch. (Used), New York, N.Y.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Special
American Insulating Mach'y Co., Phila., Pa.
Black Industries, Cleveland, Ohio
Emory, Robert J., Co., Newark, N. J.
Entwistle, Jas. L. Co., Pawtucket, R. I.
New England Butt Co., Providence, R. I.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry & Mach. Co., Trenton, N.J.
Sjogren Tool and Machine Co., Auburn, Mass.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Spooling
American Insulating Mach'y Co., Phila., Pa.
Boyd, Charles P. Corp., Philadelphia, Pa.
Eisler Engineering Co., Newark, N. J.
Emory, Robert J., Co., Newark, N. J.
Entwistle, Jas. L. Co., Pawtucket, R. I.
National Mach'y Exch. (Used), New York, N.Y.
Modern Plastic Machinery Co., Lodi, N. J.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Steel Equipment Co., Cleveland, Ohio.
Syncro Machine Co., Perth Amboy, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.
Watson Machine Co., Paterson, N. J.
Wean Equipment Corp., Cleveland, Ohio.
Wire & Textile Mach'y, Inc., Pawtucket, R. I.

MACHINERY—Spring Making
National Mach'y Exch. (Used), New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Straightening
Lewis Machine Co., The, Cleveland, Ohio.
National Mach'y Exch. (Used), New York, N.Y.
Nilson, A. H. Machine Co., Bridgeport, Conn.
Ruesch, H. J., Machine Co., Newark, N. J
Sleeper & Hartley, Inc., Worcester, Mass.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Stranding
Hughesville Machine & Tool Co., Hughesville, Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Strip Steel
Ruesch, H. J., Machine Co., Newark, N. J.
Steel Equipment Co., Cleveland, Ohio.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Swaging
National Mach'y Exch. (Used), New York, N.Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.

MACHINERY—Taping
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Testing Physical
American Optical Co., Buffalo, N. Y.
Scott Testers, Inc., Providence, R. I.

MACHINERY—Testing Equipment—Sparkers
Davis, R. L. Elec. Co., Wallingford, Conn.
Entwistle, Jas. L., Pawtucket, R. I.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Tinning Wire
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Steel Equipment Co., Cleveland, Ohio.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Tinsel Rolling Mills
American Insulating Mach'y Co., Phila, Pa.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Trolley Wire
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Tube Mill
Ruesch, H. J., Machine Co., Newark, N. J.

MACHINERY—Welding Wire
Eisler Engineering Co., Newark, N. J.
Micro Products Co., Chicago, Ill.
Syncro Machine Co., Perth Amboy, N. J.

WHERE TO BUY, Continued

MACHINERY—Winding
American Insulating Mach'y Co., Phila, Pa.
Eisler Engineering Co., Newark, N. J.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wind-up (Constant Tension, Variable Speed)
Aetna Standard Eng'g Co., The, Youngstown, O.
Industrial Ovens, Inc., Cleveland, Ohio.
Modern Plastic Machinery Co., Lodi, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Bending
Eisler Engineering Co., Newark, N. J.
O'Neil-Irwin Mfg. Co., Minneapolis, Minn.

MACHINERY—Wire Drawing
Aetna Standard Eng'g Co., The, Youngstown, O.
American Insulating Mach'y Co., Phila., Pa.
Eisler Engineering Co., Newark, N. J.
Morgan Construction Co., Worcester, Mass.
National Mach'y Exch. (Used), New York, N.Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Mach. Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Steel Equipment Co., Cleveland, Ohio
Syncro Machine Co., Perth Amboy, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Wire Forming
Eisler Engineering Co., Newark, N. J.
National Mach'y Exch. (Used), New York, N.Y.
Nilson Machine Co., A. H., Bridgeport, Conn.
O'Neil-Irwin Mfg. Co., Minneapolis, Minn.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Wire Rope
New England Butt Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wood Screw
National Mach'y Exch. (Used), New York, N.Y.

MACHINERY—Wrapping Wire Coils
Angier Corporation, Framingham, Mass.

MATERIAL HANDLING EQUIPMENT
Cleveland Tramrail, Div. of The Cleveland Crane & Engineering Co., Wickliffe, O.

MATERIAL—Resistance Heating Strand
Trauwood Engineering Co., Cleveland, Ohio.

NAILS—Wire
American Steel & Wire Co., Cleveland, Chicago, New York.
Bethlehem Steel Co., Bethlehem, Pa.
Columbia Steel Co., San Francisco, Calif.
Continental Steel Corp., Kokomo, Ind.
Keystone Steel & Wire Co., Peoria, Ill.
Roebling's, John A. Sons Co., Trenton, N. J.
Wickwire-Spencer Steel Division of Colorado Fuel & Iron Corp., Buffalo, N. Y.
U. S. Steel Export Co., New York, N. Y.

NICKEL SILVER AND PHOSPHOR BRONZE—Rod, Wire and Strip
Chase Brass & Copper Co., Waterbury, Conn.
Eastwood-Nealley Corp., Belleville, N. J.
Hudson Wire Co., Ossining, N. Y.

OVENS—Cable Lacquering
American Insulating Mach'y Co., Phila., Pa.
Industrial Ovens, Inc., Cleveland, Ohio.
Rockwell, W. S., Co., Fairfield, Conn.

OVENS—Dehydrogenizing
Carl-Mayer Corp., The, Cleveland, Ohio.
Industrial Ovens, Inc., Cleveland, Ohio.
Rockwell, W. S., Co., Fairfield, Conn.

OVENS—Industrial
Carl-Mayer Corp., The, Cleveland, Ohio.
Industrial Ovens, Inc., Cleveland, Ohio.
Rockwell, W. S., Co., Fairfield, Conn.
Ross, J. O., Engr. Corp., New York, N. Y.

OVENS—Welding Rod Coating
Carl-Mayer Corp., The, Cleveland, Ohio.
Industrial Ovens, Inc., Cleveland, Ohio.
Rockwell, W. S., Co., Fairfield, Conn.
Ross, J. O., Engr. Corp., New York, N. Y.

PAINTS—Heat Resisting
American Chemical Paint Co., Ambler, Pa.

PANS—Lead and Spelter
National Annealing Box Co., Washington, Penna.

PANS—Vulcanizing
Mossberg Pressed Steel Corp., Attleboro, Mass.

PAPER—Creped Wrapping
Angier Corp., The, Framingham, Mass.
Crepe-Kraft Company, The, Division National Waterproof Papers, Inc., Newark, N. J.

PAPER—For Coil Wrapping and Corrosion Prevention
Angier Corp., The, Framingham, Mass.
Crepe-Kraft Company, The, Division National Waterproof Papers, Inc., Newark, N. J.

PAPER TESTERS—
Scott Testers, Inc., Providence, R. I.

PATENT ATTORNEYS—
Lancaster, Allwine and Rommel, Washington, D.C.

PICKLING COMPOUNDS—
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Oakite Products, Inc., New York, N. Y.
Parkin, Wm. M., Co., Pittsburgh, Pa.

PICKLING—Hooks, etc. Acid Resisting
Gordon, Clark E., Detroit, Mich.

PICKLING TANK LININGS—
Haveg Corp., Newark, Del.
Heil Process Equipment Corp., Cleveland, Ohio.
Sauereisen Cements Co., Pittsburgh, Pa.

PIPES & FITTINGS—Acid Resistant
Haveg Corp., Newark, Del.
Heil Process Equipment Corp., Cleveland, Ohio.

PLASTIC TESTERS—
Scott Testers, Inc., Providence, R. I.

PNEUMATIC CYLINDERS
Entwistle, James L. Co., Pawtucket, R. I.

POTS—Lacquer
Industrial Ovens, Inc., Cleveland, Ohio

POTS—Lead Melting
National Annealing Box Co., Washington, Pa.
Robertson, John, Co., Brooklyn, N. Y.

POWDER—Wire Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Inc., Homer, N. Y.
Oakite Products, Inc., New York, N. Y.
Potter, Neil C., Newark, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

PRESSES—Hydraulic and Mechanical
Robertson, John, Co., Brooklyn, N. Y.

PRESSES—Lead
Robertson, John, Co., Brooklyn, N. Y.

PRESSURE VESSELS—
National Annealing Box Co., Washington, Penna.

PULLERS AND GRIPS—For Wire
Morgan Construction Co., Worcester, Mass.
Scudder, E. J., Fdy & Mach. Co., Trenton, N.J.
Sleeper & Hartley, Inc., Worcester, Mass.
Sjogren Tool and Machine Co., Auburn, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Wean Equipment Corp., Cleveland, Ohio.

PUMPS—Hydraulic
Robertson, John, Co., Brooklyn, N. Y.

REEL AND TENSION STANDS—
Davis, R. L. Electric Co., Wallingford, Conn.
Entwistle, James L., Co., Pawtucket, R. I.
Industrial Ovens, Inc., Cleveland, Ohio.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

REEL CRUTCHES—
Watson Machine Co., Paterson, N. J.

REELS & SPOOLS—Drawn Aluminum Alloy
Acrometal Products, Inc., Minneapolis, Minn.

REELS & SPOOLS—Annealing and Stranding
Acrometal Products, Inc., Minneapolis, Minn.
Apco Mossberg Co., Attleboro, Mass.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

REELS & SPOOLS—Collapsible
Entwistle, Jas. L. Co., Pawtucket, R. I.

REELS & SPOOLS—Steel
Acrometal Products, Inc., Minneapolis, Minn.
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

REELS & SPOOLS—Shipping and Shop
Acrometal Products, Inc., Minneapolis, Minn.
Apco Mossberg Co., Attleboro, Mass.
Bridge Mfg., Co., The, Hazardville, Conn.
Clark, J. L. Mfg. Co., Rockford, Illinois.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

REELS—Takeoff
Acrometal Products, Inc., Minneapolis, Minn.
Apco Mossberg Co., Attleboro, Mass.
Bridge Mfg. Co., Hazardville, Conn.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

REELS—Vulcanizing & Impregnating
Apco Mossberg Co., Attleboro, Mass.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

REELS—Wire Drawing
Acrometal Products, Inc., Minneapolis, Minn.
Apco Mossberg Co., Attleboro, Mass.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

REELS—Wire Mill
Acrometal Products, Inc., Minneapolis, Minn.
Apco Mossberg Co., Attleboro, Mass.
Bridge Mfg. Co., Hazardville, Conn.
Durkee Mfg. Co., Pine River, Minn.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

REELS & SPOOLS—Wooden
Acrometal Products, Inc., Minneapolis, Minn.
American Woodworking Co., Chicago, Illinois.
Bridge Mfg. Co., Inc., The, Hazardville, Conn.
Durkee Mfg. Co., Pine River, Minn.

REFRACTORIES—High Temperature
Norton Company, Worcester, Mass.

RESISTANCE HEATING—Annealing, Patenting, Etc.
Trauwood Engr. Co., Cleveland, Ohio.

ROD BAKERS—
Carl-Mayer Corp., The, Cleveland, Ohio.
Rockwell, W. S., Co., Fairfield, Conn.
Ross, J. O., Engineering Corp., New York, N.Y.

RODS—Nickel Alloy
Eastwood Nealley Corp., Belleville, N. J.
International Nickel Co., Inc., New York, N.Y.

RODS—Stainless Steel
Armco Steel Corp., The, Middletown, Ohio.

RODS—Wire—Non-Ferrous
Eastwood-Nealley Corp., Belleville, N. J.
Hudson Wire Co., Ossining, N. Y.
Platt Bros. & Co., The, Waterbury, Conn.

RODS—Wire, Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Indiana.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Roebling's John A., Sons Co., Trenton, N. J.
Youngstown Sheet & Tube Co., Youngstown, O.

ROPE—Wire
American Steel & Wire Company, Cleveland, Chicago, New York.
Bethlehem Steel Co., Bethlehem, Pa.
Columbia Steel Co., San Francisco, Calif.
Roebling's, John A., Sons Co., Trenton, N. J.

WHERE TO BUY, Continued

U. S. Steel Export Co., New York, N. Y.
Wickwire-Spencer Steel, Division of Colorado Fuel & Iron Corp., Buffalo, N. Y.

RUBBER AND RUBBER COMPRESSION TESTERS—
Scott Testers, Inc., Providence, R. I.

RUST PROOF COMPOUNDS—
(See Compounds—Rust Preventing)

RUST REMOVING COMPOUNDS—
(See Compounds—Rust Preventing)

SATURATION SYSTEMS—
Industrial Ovens, Inc., Cleveland, Ohio.
Watson Machine Co., Paterson, N. J.
Wire & Textile Machy, Inc. Pawtucket, R. I.

SHEARS—
O'Neil-Irwin Mfg. Co., Minneapolis, Minn.

SHEET—Steel
Armco Steel Corp., The, Middletown, Ohio.
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Roebling's, John A., Sons Co., Trenton, N. J.
Wickwire-Spencer Steel Division of Colorado Fuel & Iron Corp., Buffalo, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

SOAPS—Industrial and Wire Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Bick, Hans C., Inc., Reading, Pa.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H. Co., Inc., Homer, N. Y.
Nopco Chemical Co., Harrison N. J.
Potter, Neil C., Newark, N. J.
Swift & Company, Chicago, Ill.

SOLVENT RESIN SYSTEMS—Experimental
Industrial Ovens, Inc., Cleveland, Ohio.

STAMPINGS—Steel
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

STRIP—Brass and Non-Ferrous
Chase Brass & Copper, Waterbury, Conn.
Hudson Wire Co., Ossining, N. Y.

STRIP—Steel
Armco Steel Corp., The, Middletown, Ohio.
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Firth-Sterling Steel & Carbide Corp., Mc-Keesport, Pa.
Roebling's, John A., Sons Co., Trenton, N. J.
Youngstown Sheet & Tube Co., Youngstown, O.

SWIFTS—Take-off
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Watson Machine Co., Paterson, N. J.

TANK—Compound
Haveg Corp., Newark, Del.
Watson Machine Co., Paterson, N. J.

TANKS—Pickling
Haveg Corp., Newark, Del.
Rockwell, W. S., Co., Fairfield, Conn.
Sauereisen Cements Co., Pittsburgh, Pa.

TANKS—Steel
Mossberg Pressed Steel Corp., Attleboro, Mass.
Rockwell, W. S., Co., Fairfield, Conn.
National Annealing Box Co., Washington, Penna.

TINSEL—Cords, Decorative
Hudson Wire Co., Ossining, N. Y.
Montgomery Co., The, Windsor Locks, Conn.
North American Philips Co., Inc., New York, N.Y.

TINSEL—Electric Conductor
Hudson Wire Co., Ossining, N. Y.
Montgomery Co., The, Windsor Locks, Conn.
North American Philips Co., Inc., New York, N.Y.

TINSEL—Electric Resistance
Hudson Wire Co., Ossining, N. Y.
Montgomery Co., The, Windsor Locks, Conn.
North American Philips Co., Inc., New York, N.Y.

TINSEL—Lame, Silver and False Gold
Hudson Wire Co., Ossining, N. Y.
Montgomery Co., The, Windsor Locks, Conn.
North American Philips Co., Inc., New York, N.Y.

TINSEL—Thread, Silver and False Gold
Hudson Wire Co., Ossining, N. Y.
Montgomery Co., The, Windsor Locks, Conn.
North American Philips Co., Inc., New York, N.Y.

TINSEL—Thread, Decorative
Hudson Wire Co., Ossining, N. Y.
Montgomery Co., The, Windsor Locks, Conn.
North American Philips Co., Inc., New York, N.Y.

TOOLS—Wire Cutting
Porter, H. K., Inc., Everett, Mass.

TRAMRAIL SYSTEMS—
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, O.

TRAVERSES—For Reels
Entwistle, James L. Co., Pawtucket, R. I.
Hubbard Spool Company, Chicago, Ill.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

TRAVERSE MECHANISMS—
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.
New England Butt Co., Providence, R. I.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.
Watson Machine Co., Paterson, N. J.
Wire & Textile Machy, Inc. Pawtucket, R. I.

TUBE BENDERS AND FORMERS—
O'Neil-Irwin Mfg. Co., Lake City, Minn.
Ruesch, H. J. Machine Co., Newark, N. J.

VALVES AND FITTINGS—Acid Resistant
Haveg Corp., Newark, Del.

VARNISHES—For Insulation
General Electric Co., Schenectady, N. Y.
Standard Varnish Wks., Staten Island, N. Y.

VULCANIZERS—
Watson Machine Co., Paterson, N. J.

VULCANIZING PANS—
American Insulating Mach'y Co., Phila., Pa.
Mossberg Pressed Steel Corp., Attleboro, Mass.

WELDERS—Spot and Butt
Eisler Engineering Co., Newark, N. J.
Micro Products Co., Chicago, Ill.
Sciaky Bros., Inc., Chicago, Ill.

WIND-UP AND UNWIND SYSTEMS—Continuous
American Insulating Mach'y. Co., Phila., Pa.
Davis, R. L. Electric Co., Wallingford, Conn.
Entwistle, James L., Co., Pawtucket, R. I.
Industrial Ovens, Inc., Cleveland, Ohio.
Watson Machine Co., Paterson, N. J.
Wire & Textile Machy, Inc. Pawtucket, R. I.

WIRE—Aluminum
Aluminum Co. of America, Pittsburgh, Pa.
Malin & Co., Cleveland, Ohio.

WIRE—Cast
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Cold Heading
American Steel & Wire Co., Cleveland-Chicago, New York.
Armco Steel Corp., The, Middletown, Ohio.
Bethlehem Steel Co., Bethlehem, Pa.
Columbia Steel Co., San Francisco, Calif.
Continental Steel Corp., Kokomo, Ind.
Keystone Steel & Wire Co., Peoria, Ill.
Roebling's John A., Sons Co., Trenton, N. J.
U. S. Steel Export Co., New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Electric
Chase Brass & Copper, Waterbury, Conn.
Hudson Wire Co., Ossining, N. Y.
Malin & Co., Cleveland, Ohio.

WIRE—Enameled for Coils
North American Philips Co., Inc., New York, N.Y.
Winsted Div. of Hudson Wire Co., Winsted, Conn.

WIRE—Manufacturers
American Steel & Wire Co., Cleveland-Chicago & New York.
Armco Steel Corp., The, Middletown, Ohio.
Bethlehem Steel Co., Bethlehem, Pa.
Chase Brass & Copper, Waterbury, Conn.
Columbia Steel Co., San Francisco, Calif.
Continental Steel Corp., Kokomo, Ind.
Firth-Sterling Steel & Carbide Corp., Mc-Keesport, Pa.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Keystone Steel & Wire Co., Peoria, Ill.
Roebling's, John A., Sons Co., Trenton, N. J.
Tennessee Coal, Iron & R. R. Co., Birmingham, Ala.
U. S. Steel Export Co., New York, N. Y.
Wickwire Brothers, Inc., Cortland, N. Y.
Wickwire Spencer Steel Div., of Colorado Fuel & Iron Corp., Buffalo, N.Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Music
American Steel & Wire Co., Cleveland, Chicago-New York.
Columbia Steel Co., San Francisco, Calif.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Malin & Co., Cleveland, Ohio.
Paramount Wire Co., New York, N. Y.
U. S. Steel Export Co., New York, N. Y.
Wickwire-Spencer Steel Division of Colorado Fuel & Iron Corp., Buffalo, N. Y.

WIRE—Nickel & Nickel Alloy
Eastwood-Nealley Corp., Belleville, N. J.
International Nickel Co., Inc., New York, N. Y.

WIRE—Nickel Silver and Phosphor Bronze
Chase Brass & Copper, Waterbury, Conn.
Eastwood-Nealley Corp., Belleville, N. J.
Hudson Wire Co., Ossining, N. Y.
Malin & Co., Cleveland, Ohio.

WIRE—Non-Ferrous to Specification for Special Purposes
Chase Brass & Copper, Waterbury, Conn.
Eastwood-Nealley Corp., Belleville, N. J.
Hudson Wire Co., Ossining, N. Y.
North American Philips Co., Inc., New York, N.Y.
Paramount Wire Co., New York, N. Y.
Winsted Div. of Hudson Wire Co., Winsted, Conn.

WIRESERVING—Paper and Cotton
Paramount Wire Co., New York, N. Y.

WIRE—Spring
Armco Steel Corp., The, Middletown, Ohio.
American Steel & Wire Co., Cleveland - Chicago
Bethlehem Steel Co., Bethlehem, Pa.
Columbia Steel Co., San Francisco, Calif.
Continental Steel Corp., Kokomo, Indiana.
Firth-Sterling Steel & Carbide Corp., Mc-Keesport, Pa.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Keystone Steel & Wire Co., Peoria, Ill.
U. S. Steel Export Co., New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Stainless Steel
American Steel & Wire Co., Cleveland-Chicago-New York.
Armco Steel Corp., The, Middletown, Ohio.
Columbia Steel Co., San Francisco, Calif.
Firth-Sterling Steel & Carbide Corp., Mc-Keesport, Pa.
Tennessee Coal, Iron & Railroad Co., Birmingham, Ala.
U. S. Steel Export Co., New York, N. Y.

WIRE—Steel—Also Coppered Steel—Also Galvanized Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Indiana.
Firth-Sterling Steel & Carbide Corp., Mc-Keesport, Pa.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Keystone Steel & Wire Co., Peoria, Ill.
Paramount Wire Co., New York, N. Y.
U. S. Steel Export Co., New York, N. Y.
Wickwire Brothers, Inc., Cortland, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Straightening and Cutting—
Paramount Wire Co., Inc., New York, N. Y.
Pittsburgh Cut Wire Co., Pittsburgh, Pa.

WIRE—Zinc
Platt Bros. & Co., The, Waterbury, Conn.

WIRE CLOTH—Industrial
Roebling's John A., Sons Co., Trenton, N. J.
Wickwire Brothers, Cortland, N. Y.
Wickwire-Spencer Steel Division of Colorado Fuel & Iron Corp., Buffalo, N. Y.

WIRE TESTERS—
Scott Testers, Inc., Providence, R. I.

WIRE, WEAVING—Non-Ferrous
Chase Brass & Copper, Waterbury, Conn.
Hudson Wire Co., Ossining, N. Y.
Paramount Wire Co., New York, N. Y.

WRAPPING PAPER—Creped
Angier Corporation, Framingham, Mass.
Crepe-Kraft Company, The, Division National Waterproof Papers, Inc., Newark, N. J.

YARNS & TAPES—
Du Pont de Nemours, E. I., Co., Wilmington, Del.
General Electric Co., Schenectady, N. Y.
Owens Corning Fiberglas Corp., Toledo, Ohio.
Twitchell, E. W., Philadelphia, Pa.

YARN TESTERS—
Scott Testers, Inc., Providence, R. I.

The WATSON MACHINE COMPANY

ESTABLISHED 1845

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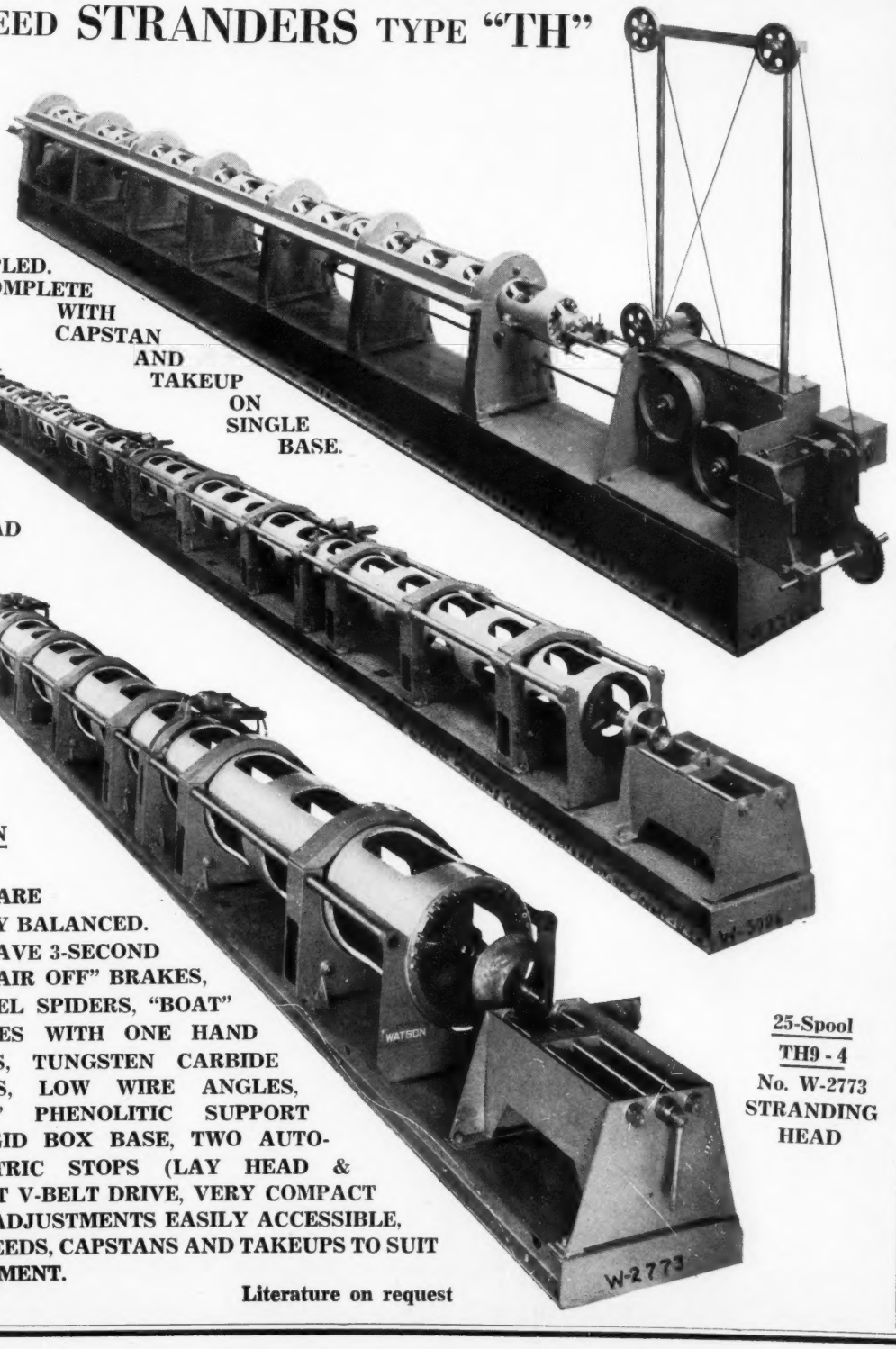
Wire & Wire Products

November, 1948

ELECTRICAL WIRE AND CABLE, WIRE ROPE AND CORDAGE MACHINERY

HIGH SPEED STRANDERS TYPE "TH"



19-SPOOL
TH2 - 3
No. W-2577 STRANDING MACHINE. CLOSE COUPLED, COMPLETE WITH CAPSTAN AND TAKEUP ON SINGLE BASE.

46-SPOOL
TH6 - 8
No. W-3006 STRANDING HEAD

25-Spool
TH9 - 4
No. W-2773 STRANDING HEAD

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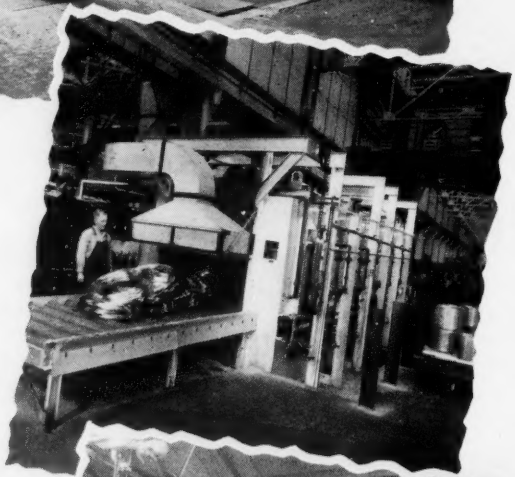
Literature on request



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